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A FEW POINTS ON REINFORCED CONCRETE DESIGN.

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In designing reinforced concrete structures, one is continually meeting minor problems upon which very little satisfactory information can be obtained from the numerous treatises on the subject. In the following paper I shall endeavor to enumerate a few points in design which are sometimes apparently not given the attention they deserve.

Footings have probably given more trouble to the designer, the erecting contractor and the owner than anything else in connection with reinforced concrete. Unequal settlement in footings is responsible for numerous unsightly deformities and cracks and some collapses.

The common type of reinforced concrete column footings is, of course, easily dealt with, and differs from a plain concrete footing only in its being designated as a flat slab to resist bending, instead of being sloped off as a pedestal. In this type of footing the centre of pressure coincides with the centre of gravity of the footing area, and the required size is formed directly from the load to be carried and the resisting power per square foot of the soil. Trouble is sometimes caused by having a footing too large in comparison with the size of the other footings in the same building. This is particularly liable to happen in the design of wall column footings in the following manner:

If the footings are designed to carry the total dead and live load, figuring each flooring of the building fully loaded, then the interior footings will, under probably loading, not stress the soil as highly as will the wall column footings. The reason for this is, of course, that the load figured to come on the wall column footings is usually about 70 per cent. dead load (which is present under all conditions), and 30 per cent. live load (which is never all there), while that figured on the interior column footings is generally about 40 per cent. dead and 60 per cent. live. As the live load on the footings of a building of five storeys or more is never more than 50 per cent. of the total live load, it will readily

be seen that the pressure per square foot is less on interior footings than on exterior ones.

As all soil is compressed under any loading, the interior footings will not settle as much as the exterior ones, and the result is sometimes the cracking of floor beams and slabs.

The difficulty is overcome, to a certain extent, by the cus-

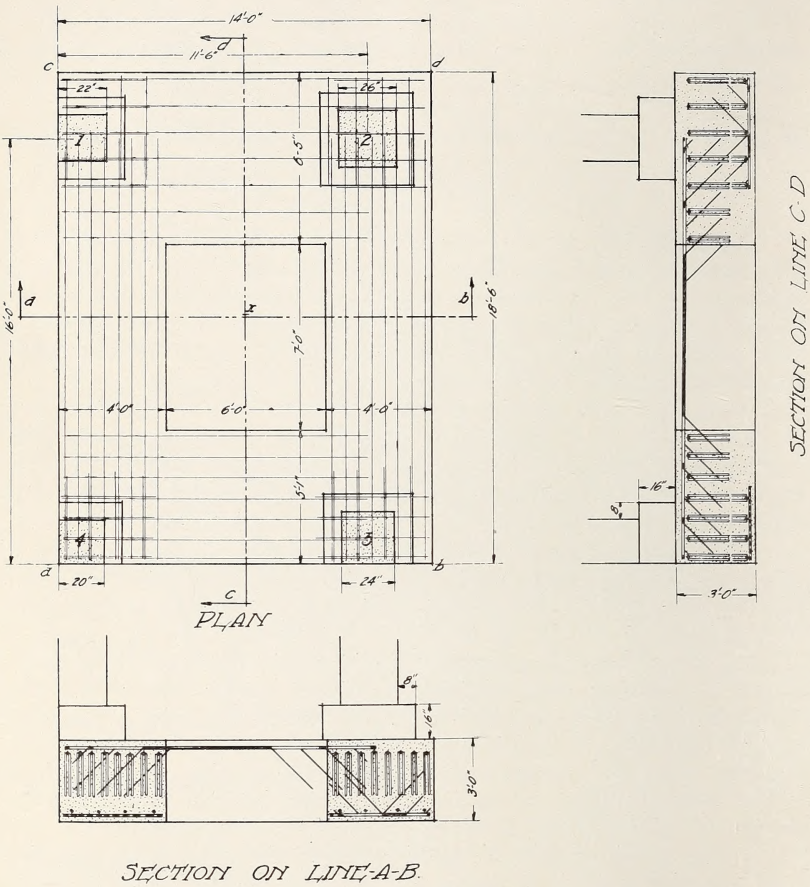

FIG. 1

tom of reducing the live load by about 50 per cent. in buildings of over a certain number of storeys. This, however, would appear to be insufficient, and it would seem that either a greater reduction should be figured in designing interior column footings, or else no reduction at all should be allowed in figuring exterior footings. It would also appear to be wise to even add a small

percentage on corner column footings, as a much larger portion of the wall coming on these is dead weight.

It very often occurs that the footings under wall columns cannot be built to extend beyond the outside line of the column. In cases of this kind some sort of combination footing should be used. This is sometimes done by carrying the column in question on a cantilever beam, pinned down at the other end by one of the other columns. Care must be taken in this type to reduce the footing under the second column in proportion to the upward thrust from the end of cantilever beam.

A simpler method of treating the above is as follows:

Consider the wall column in question and the nearest interior column as acting together on a combined footing. Figure the loads coming on both columns and find the position of their resultant load. Add the two loads and divide by the soil value per square foot. This will give the required footing area. Design a footing of this area and varying in width from one end to the other in such a way that the centre of gravity of the area will coincide with the point of application of the resultant from the two column loads. The thickness of the footing and the reinforcing material must now be designed, treating the footing as an inverted beam, supported at the two columns and resisting the upward pressure of the soil, which will be of an intensity per square foot equal to the soil value minus the weight per square foot of the concrete in the footing.

The above method can be used for designing combination footings for any number of columns.

Figure I. shows a footing of this type designed to carry the four columns indicated, whose loads were: 1: 267,000 pounds; 2: 347,000 pounds; 3: 284,000 pounds, and 4: 197,000 pounds. The soil value assumed was 5,000 pounds per square foot. Column 1 was a corner column, 2 and 3 were wall columns, and 4 was an interior column. The footings could not extend beyond the lines A. B. and A. C. The footing was designed as follows:

Sum of column loads = 109,500 pounds.
Sum of moments about side a.b. = 10,272,166 foot pounds.

Therefore centre of pressure is $\frac{10272166}{109500} = 9'-4\frac{1}{2}''$ from a.b.

Taking moments about line a. c. we find centre of pressure is 7 ft. 0 in. a.c.

This locates the point x, the centre of pressure.

Area of footing required $= \frac{109500}{5000} = 219$ sq. ft.

The lengths, 18 ft. 6 in. and 10 ft. 0 in. of the sides a.c. and a .b. are now arbitrarily assumed.

Area of rectangle a. b. c. d. = 259 sq. ft.

Area of footing required = 219 sq. ft.

Area to be deducted = 40 sq. ft.
Deduct area, E.f.g.h. 7 x 6 = 42 sq. ft.
Let x = distance from a. c. to centre of gravity of area to be deducted.
Let Y = distance from a. b.

$$\text{Then } x = \frac{259 \times 7 - 217 \times 7}{42} = 7 \text{ ft. } 0 \text{ in.}$$

$$\text{And } y = \frac{259 \times 9.25 - 217 \times 9.38}{42} = 8 \text{ ft. } 7 \text{ in.}$$

which locates the position of the area E.f.g.h., which will give a footing whose centre of gravity coincides with the centre of pressure x.

The footing was then designed for bending by treating it as four beams between the four columns, figuring on 5,000 pounds per square foot upward pressure minus the weight of the concrete in the footing.

While the centre of pressure will, of course, shift under different conditions of column loading, still the variation cannot be sufficient to cause a serious settlement of any part of the footing.

In some cases it is very difficult to economically combine a wall column footing with any other footing. Where this is the case the footing is increased towards the inside of the building and along the wall. When this is done, the column must, of course, be tied in at the top and figured to resist the bending caused by the eccentric loading on the footing. This bending is generally increased by the bending moment from the eccentricity brought on the column from the floor loads.

A point in designing reinforced concrete which is often overlooked is the bending produced in wall columns carrying long span beams. This moment seldom gives trouble in the lower tiers of columns in a building of any considerable height as, in such cases, the columns are so heavily loaded that the eccentricity is not sufficient to produce actual tension in the outside of the column.

The common practice of designing wall columns 20 per cent. heavier than interior columns does not always overcome this tendency to crack from bending, as the extra strength is not applied in the proper place.

Consider the roof columns of a building of considerable width in which the roof beams span from side to side with no intermediate support. The usual custom is to carry the column reinforcement to within a few inches of the top of the roof slab and to bend the anchor bars of the beams down into the columns the usual depth to prevent cracking in the upper surfaces of the beams near the ends. In a building designed in this way the result is pretty sure to be cracks across the outer surfaces of the columns immediately under the level of the bottom of the beams,

even though the roof be under no load other than the dead load of the structure itself. The reason for this is that the beam deflects under its own weight and the weight of slab carried. This deflection produces a tension in the upper surface of the beam at the end, which tension is also present at the outer surface of the column, where it is altogether liable to produce large cracks. These cracks can be seen in many buildings. They should be provided against by increasing the reinforcing steel in the outer side of the column. This reinforcement in these columns (if the same are not bent over as described) increases the liability to crack, owing to the fact that they must be embedded to a greater distance than deformed bars in order to develop their tensile strength. Cracks of this nature are, of course, more unsightly than they are dangerous, for beams supported in this manner are usually designed as non-continuous over the supports and should be of the required strength, whether pinned down to the columns or not. However, the bond with the column is an added strength to the beam and should be preserved.

The placing of brackets under a beam of the above description does not overcome the difficulty and is, in my mind, poor practice. The brackets tend to spread the columns by causing the beam to act as an arch whose thrust is not properly taken care of, and cracks will very likely occur on the outer surface of the columns under the brackets. This construction acts, to a great extent like roof truss without a tie rod.

Reverse bending should be given particular attention in the design of highway bridges where heavy moving loads have to be provided for. In short span culverts, where a flat slab is used, this reverse bending at the abutments, if not properly taken care of, may result in a failure which has all the appearance of a shear failure, and such it may be after a certain point, although it has probably started in tension cracks in the upper surface of the slab.

Consider a culvert, let us say, of 12 feet clear span, to be designed to carry a 15-ton road roller. The slab is designed as non-continuous, and enough steel is inserted in the bottom to give a resisting moment to properly take care of the total maximum bending moment liable to come on the culvert. In all probability the concrete itself will figure to take care of all the shear at 50 pounds per square inch, and therefore no extra provision is made against through shear.

At first glance this culvert would appear to be properly designed to insure against failure from any cause, for, as the slab is not figured continuous over supports, it does not seem necessary to put any steel in the top of the slab at the abutments. This conclusion would be safe if the slab were cast separate from the abutments, but if (as is nearly always the case) the

abutments and slab are monolithic, the following is liable to occur:

A heavy, vibratory load comes to the centre of the span and produces considerable deflection and, as the slab is tied down to the abutment, tension is produced in the upper surface of the slab and on the outer surface of the abutments. The slab, being thinner than the abutment, cracks on top just inside the line of the abutment. Then, as the load approaches this point, the shear is increased and the cracked concrete is probably not capable of resisting this shear, and collapses. This failure might have been prevented in three ways, namely, by the use of top steel, by the use of steel shear members, or by having a complete horizontal joint between the slab and abutment.

The advantages of what is known as flat ceiling construction are many, the most desirable among them being the appearance produced and the economy in floor height. The chief disadvantage in the most common types is our lack of scientific data on the subject. In a well-known type, opinions differ nearly 100 per cent. as to the bending moment to be figured in slabs under the same loading. In the Engineering Record of 24th December, 1910, there is an account of some measurements made to obtain the strain existing in different portions of a flat slab floor under working loads. From these strains the existing stresses are figured. The results of these measurements appear to indicate that some designers are over sanguine about the carrying capacities of this type of floor.

A more conservative design of flat ceilings is effected by increasing the width of the beams and decreasing their depth until the under side of the beams is flush with the under side of the slab. The slab in these cases is usually made up of small reinforced concrete joists with tile fillers in between, and two or three inches of concrete over the top to aid in compressive resistance.

In this type of floor the stresses are known and the strength can be figured along the same lines as the ordinary slab and beam construction. The tile fillers are placed as much as possible below the natural axis of the slab so as not to decrease the dead load of the floor. This type of floor is not as economical in steel as the usual slab and beam construction, on account of the decreased arm of the resisting couple of the steel in tension and the concrete in compression.

To-day, reinforcement in a rectangular panel, designed according to the accepted theory of reductions in bending moments, effects economy in concrete only. If the bending moments each way be reduced in the usual manner of multiplying by $\frac{B^4}{A^4 + B^4}$ for the shorter span and by $\frac{A^4}{A^4 + B^4}$ for the longer, where A represents the shorter span and B the longer, the steel may be

slightly reduced by placing less near the edges of the panel than near the centre. This reduction is, however, offset by the fact that, in using bar reinforcement, the amount of resistance of the upper layer of steel is decreased by the decrease in the resisting arm of the forces. The saving in concrete is, of course, effected by figuring it to take its full working compression in two directions at right angles to one another.

Before closing, I would like to enter a plea for the standardization of unit stresses and formulae in reinforced concrete design throughout Canada. Some things, of course, cannot be standardized, but such points as ratio of the moduli of elasticity of steel and concrete, the allowable working compressive strength of concrete, both in bending and in direct compression, the limits of Tee action, etc., might be definitely settled and adhered to by all designers. If it is safe in one city to design a continuous beam uniformly loaded to resist a bending moment of one-twelfth WL, then it is equally safe to do the same in the next city, despite the fact that the second city insists on it being designed for one-eighth WL. Other points might also be straightened out, such as whether a specification should insist on using 12 for the ratio of the modulus of elasticity of steel to that of concrete, when in another part it calls for working stress of 350 pounds per square inch for the concrete in a column and 10,000 pounds for compressive steel embedded in the same column.

INSPECTION OF CONCRETE.

E. A. JAMES, A.M., Can. Soc. C.E.

Although concrete was a material of construction in the days when the Roman Empire flourished, yet we speak of it as one of the modern materials of construction. For several centuries other materials were more convenient and more fashionable, and with the settlement of America the plentiful supply of timber and the ease with which it was made suitable for construction work, marked timber the cheap material of construction, and it was not until the '70's that cement and concrete again entered into construction work in any great quantities.

To-day, the annual consumption of cement in Canada is close unto five million barrels, which represents in completed structure many times five million dollars' worth.

Where the uses are so varied, as are those to which concrete is placed, it is but natural to expect to hear of failure, and where the amount of money expended annually is so large, it is reasonable to suppose that every effort should be made to ensure good work.

In concrete work, as in other classes of construction, good design and good materials are necessary, and, granting that we

have good design and good materials , a class of well-skilled workmen should produce a finished material of a high order.

Concrete, however, has suffered more than any other building material because of inferior workmen, and this has been brought about largely by those interested in the early days in the sale of cement, who claimed as one of the chief reasons why it should be largely used, was the cheapness of placing, because it did not require skilled laborers.

Fortunately, we do not hear so much of the claim as formerly, for it is well recognized that workmen can, with the same ingredients, produce various grades of concrete.

Although among the first of the modern concrete structures many were well and substantially made, yet there were a number of serious failures, and because the engineers themselves were not any too familiar with concrete construction, and because of this recurring failure and the fact that most of the workers in concrete were men imperfectly skilled, a system of careful inspection was inaugurated.

While the necessity of inspection depends to a certain extent upon the nature of the material and the production, it is always a question of just when and where and to what extent it pays to inspect. In concrete work inspection must be made of the component parts, the sand, the gravel, the cement and the water must be examined, as well as the concrete, while it is being mixed and poured.

The scope and possibilities of a system of inspection enlarges greatly with specialization.

Inspection should be planned to accomplish at least expense, the best results, which may be numerated something as follows:

1. To prevent loss or defects by accidents or delays.
2. To prevent loss of time and material on work already beyond repair.
3. To prevent the necessity of replacing defective work.
4. To prevent decrease in quality because of the demand for increase in quantity.
5. To point out imperfections in alignment, methods and material.
6. To record proper allowances for unavoidable extras.
7. To draw the attention of the superintendent to workmen who must be better instructed or trained.
8. To stimulate good-will through fairness, in fixing responsibilities.

Inspection organized to cover any one or all of these purposes will be similar in personality, varying only with the degree of perfection required.

Before it can be determined just when and where it pays to inspect, the following conditions must be satisfied:

1. Responsibility must be fixed with certainty.
2. The inspection must not cause unnecessary friction.

3. The inspector must have to do with equality only, not design.

4. The responsibility for defective work must be placed upon the workman as well as upon the inspector.

Responsibility must be fixed with certainity.

As inspection has for its purpose the pointing out of the defects, it is necessary for the inspector to be able to locate the cause of the defect. One of the most foolish things that can be done is attaching blame to the wrong person, and unless it is possible to discover immediately just when and where the cause of the defect lies, the fixing of responsibility is very difficult. It is, therefore, necessary to have the material on the ground in sufficient time for thorough inspection before it is mixed, for even after the inspector has detected the defect, the responsibility is not necessarily fixed. The error may be due to wrong specification, poor material, defective measurement, defective mixing, or even unsuitable weather conditions. It is, therefore, necessary that instructions and specifications must be in writing.

Inspection must not cause uncessary friction.

No system of inspection which would simply complain of defects, without attempting to trace the cause, or to assist in the improving of conditions, will be of any assistance. It certainly would not tend to happy relations between contractor and engineer. So it becomes necessary, if full benefits are to be derived from rigid inspection, not only to point out the defects, but the inspector should be in a position to trace the cause and to suggest a remedy. Defective work must be detected as soon as possible, so that the conditions under which the work was done may be fresh in the workman's mind, and the responsibility with certainty attached to him when the defect it through careless workmanship.

The inspector must have to do with quality only, not design.

To point out defects will not necessarily stop the repetition and, although it may be the duty of the inspector to trace the cause, fix the responsibility and suggest the remedy, the inspector must not have to do with applying the remedy or of interfering with the workmen.

When the inspector has reported defects in material or workmanship to the engineer and contractor, or their representatives, he must content himself with awaiting the corrections through the proper officials, although it should be within his power to stop or reject the work until there is an opportunity for investigation, and to take upon himself these responsibilities, he must have knowledge equal to that of the superintendent of the work.

Responsibility for defective work must be placed upon the workman as well as upon the inspector.

While we have stated that the inspector should not interfere

with the workman, yet the knowledge that he is present will have a disciplinarian effect and will prevent the sacrifice of quality for quantity. Inspecting alone will not reduce bad workmanship to a minimum, but the workman must be supplied with proper tools, proper instructions, and must be trained in his work and held responsible for the quality of his work. He must be trained to inspect his own work. We have known cases where the men were paid a bonus for saving cement, and where this is the case it almost requires as many inspectors as men to secure compliance with specifications. Where it is known that the contractor is encouraging his men to skimp the work, the inspector should lay his information before the engineer, and at once vigorous measures should be taken to remove such contractor from the work, for he will not do good work, no matter what the inspection is.

Plan of Inspection.

There are many plans of inspection, any of which may get good results, and all of which may fail in securing good results. Inspection depends more upon the inspector than upon the method.

You may have inspection by central bureaus which retain men who are experts in their line of work, who report first to their bureaus, or to the engineer in charge of the work, as may be arranged.

You may have inspection by your own local staff or foreman, or you may require such guarantee that inspection at the end of one or two-year periods will be all that is necessary. The plan of inspection to be adopted will necessarily depend on the character of work being carried out.

The Duties of the Inspector.

It should be the duty of the inspector to see that all forms are erected on the lines laid down by the engineer, that these forms are stiff and well braced, and that all material and workmanship are in accordance with specifications. He should look after the removal of forms and see that the concrete is not injured in the removal.

Aside from concrete walks, form work is the most difficult to get properly placed, and it is much easier to develop a good inspector out of a good carpenter than out of a good concrete worker.

If the work is to be done at night under artificial light, it will be necessary to increase the staff of inspectors, for concrete that can be detected in the day time, by color, will not show a lack of proper mixing of materials under artificial light. In fact, where high class work is required, or in finishing surfaces, as a rule, it is better not done at night at all.

The cost of inspection is variable, being in some cases as low as one per cent. of the total cost and as high as two and a

half per cent. I think it is a usual thing two per cent. should be allowed for inspection, and good inspection is cheap at that price.

ELECTROLYTIC RECTIFIER.

R. H. HOPKINS, B.A., Sc.

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The general use of alternating current for the transmission of energy for light and power, and the limitations of this form of energy for some purposes, makes necessary some apparatus for the transformation of alternating current into direct current.

There are a number of methods available; the use of the motor generator set, the rotary converter, and the mercury arc rectifier, being some of them. Where the amount of power to be used is considerable, a motor generator set or a rotary converter will be used. When the amount of power to be used is small, and especially where it is used in charging storage batteries, these machines are not as satisfactory. Here, then, is the field for the mercury arc rectifier and the electrolytic rectifier. The smaller the amount of power necessary, and the more the first cost figures, the greater are the odds in favor of the use of the electrolytic rectifier.

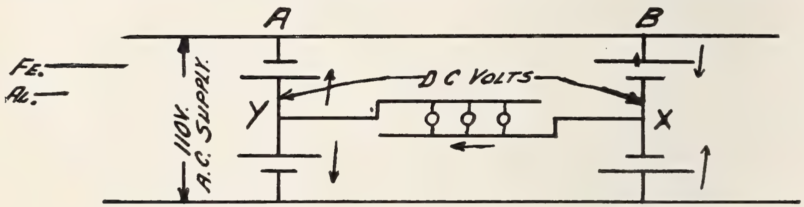
The electrolytic rectifier is a chemical cell for the rectifying of alternating current. Its rectifying action is due to a high resistance to flow of current in one direction and not in the other that certain metals have when placed in some electrolytes.

If two plates of aluminium which have been charged (I will mention this later) are placed in an electrolyte such as a solution of ammonium phosphate, sodium phosphate, borax, etc., and connected to a direct current supply, no current will flow; if, however, we connect a plate of iron and one of aluminium to the same supply, the iron being connected to the positive line, the cell will act as a direct short circuit. It is hardly right to look upon the action of the aluminium as regards flow of current when it is an anode as being due to resistance. It is rather a counter electromotive force, which varies with the impressed voltage up to as much as 600 volts per cell. It also varies with the electrolyte. This counter electromotive force is due to a film of aluminium hydroxide that is formed on the aluminium. This film is very thin, being comparable in thickness to the length of a wave of light, and it seems to be formed of two parts, an insoluable shell holding a gaseous body.

If 110 volts be applied to a circuit consisting of two plates of aluminium in a solution of ammonium phosphate, an enormous current flows that rapidly dies to zero, and the plates are said to be charged. On examining the plates it will be noticed that they have a frosty appearance; this is due to the film that

has been formed on them. The statement that the current drops to zero is not quite true, for if the voltage is direct you will have a minute leakage current, and if alternating, a leakage current, and superimposed upon it a condenser current of greater magnitude, but still of small value. Steinmetz says this current is about .01 ampere per square inch of plate surface, but does not say for what voltage or frequency. With plates of 10 square inches surfaces in an electrolyte of ammonium phosphate, a current of .35 amperes was obtained at 60 cycles, 110 volts, and with the General Electric Company's lighting arrester solution, a current of .15 amperes for plates of 20 square inches on 110 volts, 60 cycles, was obtained.

The connections commonly used for an electrolytic rectifier are illustrated in Fig. 1. On account of the impedance of the choke coil, practically no current flows through it, but intermit-



CONNECTIONS FOR 4 CELL RECTIFIER

FIG. 1

tent direct current flows from the centre of it without a serious drop on account of the choke coil acting as a one to one series transformer. Let B be positive. Current cannot enter the solution by an alumium electrode so it flows to centre tap of the choke coil through the direct current circuit, to the iron plate, to the aluminium plate on the other side of the line. Now, this current flowing in the half of the transformer creates a magnetic flux, and unless this flux is balanced the current cannot flow freely. This flux is balanced by the flux created by a secondary or induced current to the other half of the choke coil, which is equal and opposite to the first current. It flows from centre point of coil through the direct current circuit to the iron plate, to the aluminium plate, and completes its circuit in the coil. Hence you will have twice the current at half voltage in the direct current circuit. These relations are theoretical and are not obtained in practice.

The connections for the use of an aluminium rectifier without a choke coil are illustrated in Fig. 2. There are four cells, each consisting of an iron plate and an aluminium plate in the electrolyte. Two cells are connected in series opposition with the aluminium plates connected to the supply, and two in series op-

position with the iron plates also connected to the supply. Consider the line AB positive. Current flows from B to X to Y to C, and if the line CD be positive, current flows from D to X to Y to

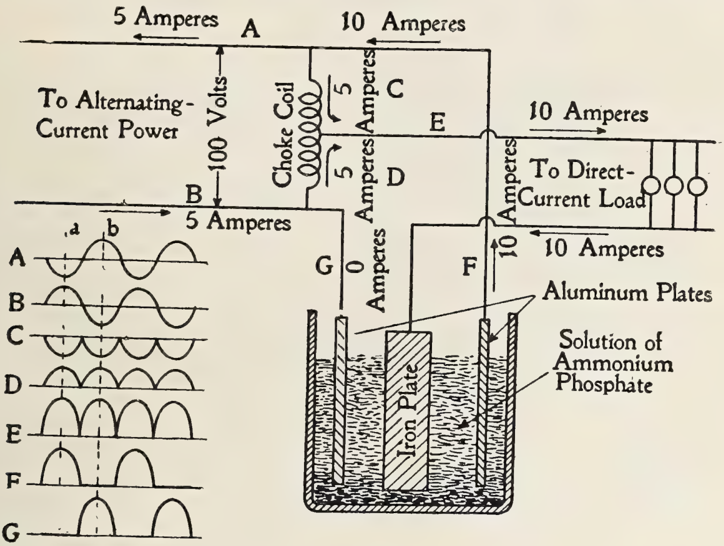


FIG. 2

A. In other words, there is direct current flowing from X to Y independent of which line is positive.

The results that can be obtained from a small rectifier with connections made as illustrated in Fig. 1 are shown by a set of curves, Fig. 3. This rectifier had two aluminium plates two inches by seven inches, and an iron plate six inches by seven inches. The electrolyte was a saturated solution of pure ammonium phosphate. Figs. 4 and 5 are taken from oscilligrams of the voltage and current in different parts of the circuit. The alternating current supply was from an old, smooth core, ring-wound alternator, which explains the smooth curves. With a modern slotted armature alternator as a supply, the general shape of the curves is similar, but they are somewhat distorted by the harmonics caused by the teeth of the alternator. These harmonics are considerably amplified by the condenser action of the rectifier. Curve 1, Fig. 4, is of the supply voltage; Curve 2, the supply current, and Curve 3 shows the direct current voltage. Curve 4, Fig. 5, shows the direct current obtained, and Curves 5 and 6 show the components of 4, i.e., the currents in lines G and F. (Fig. 1). The theoretical values of the currents in the different parts of the circuit are illustrated in Fig. 1, the dotted line " a " indicating the values of the currents in the different parts of the circuit (which are lettered to correspond) at the instant current at B is flowing to the choke coil. The dotted line "s" indicates

the values of the currents at the instant current at B is flowing away from the coil.

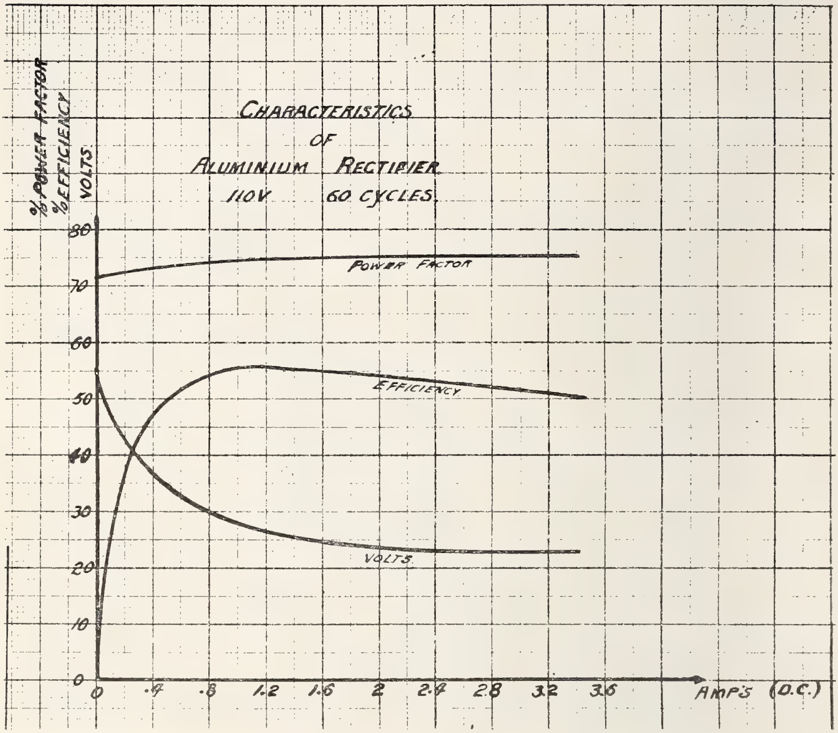


FIG. 3

These rectifiers are used commercially for charging batteries for electric automobiles, batteries for use with pipe organs,

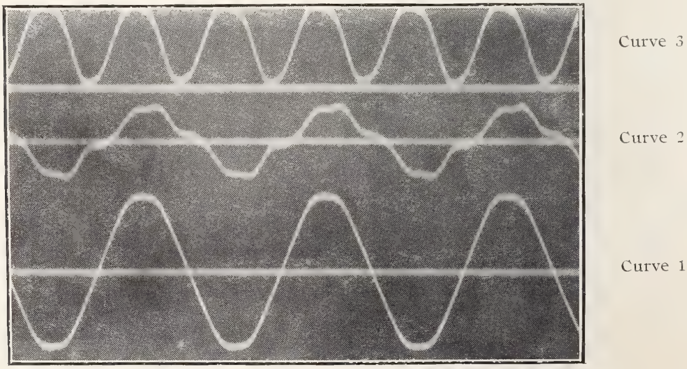
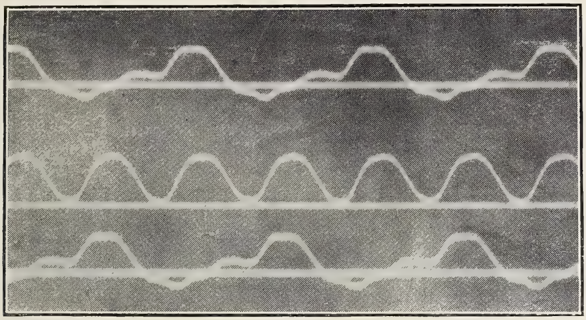


FIG. 4

and batteries for ignition outfits. Their main advantage is low first cost. The disadvantages are poor efficiency and large size. The efficiency is about 60 per cent. as a maximum, 50 per cent. being a good commercial efficiency. As to size, a rectifier for continuous operation, delivering three amperes, requires alumin-



Curve 5

Curve 4

Curve 6

Fig. 5

ium plates of twenty square inches each, and an iron plate of from seventy-five to one hundred square inches, besides which the cell must have a radiating surface of from three to four square feet. This radiating surface, unless some device for cooling is used, is essential, as the efficiency drops rapidly with a rise in temperature. The power factor is never above 90 per cent., but is not necessarily low, if the rectifier is fully loaded. The maximum voltage that can be used per cell is about one hundred and seventy-five volts. Above this voltage the breakdown voltage of the film is reached. The breakdown voltage may be increased by a change of the electrolyte, but this lowers the efficiency of the cell.

As a cheap and good means of charging a few storage battery cells from an alternating current supply, the aluminium rectifier seems to give good satisfaction.

SEWAGE EFFLUENTS AND PUTRESCIBILITY.

T. A. DALLYN, B.A. Sc.

Engineer in charge Ontario Board of Health Experimental Station.

The subject under discussion, "Sewage Effluents and Putrescibility," is one to which our attention is being constantly attracted as Canada — more especially our Province — becomes more and more thickly populated.

As our friend and professor—Dr. Ellis—has told us, there was a time when one might conveniently dispose of all refuse by throwing it out of the window or around the back entrance. In-

deed, it is only some fifty years since such was the custom in many places in England. In many of the fishing villages the accumulation of trade refuse, such as offal, was such as to make our present-day aesthetic standards stand back in fearsome horror. As was natural in conditions such as these, due to carelessness and lack of all sanitary precautions, disease and epidemics abounded. It was also natural for the sanitarians of that day, when the theory of the spontaneous generation of the organisms of putrefaction held sway, to believe that these rotting masses also produced the cause of the epidemics, the bacterial organ of disease being as yet only dimly suspected by some few workers in surgery.

We find many references, at this date, to the atmospheric conditions during these epidemics, and lengthy assertions upon the effect of the night vapours. Science and observation have since taught us that while these conditions, when prevailing for a considerable period, may lower one's resistance to bacterial invasion, yet they themselves are not the primary cause of the disease. Looking back, one may see many ways in which such conditions may affect the life of a community: (1) Drought lessening the dilutions of stream contamination; (2) Seasonal migrations to the upper reaches of streams which, lower down, act as water supplies; (3) Stagnation of streams, with the subsequent production of algae growths forcing whole communities to seek for other sources of supply where these secondary sources may receive graver contamination than the neglected one. Extent of turbidity and taste are not good nor safe guides to a hygienic water supply.

Pasteur, in his work on yeasts and ferments (1862), discovered a method by which he could sterilize all manner of putrefactive material by heat. Then using vessels that could be sealed while the contained fluid was still sterile, he demonstrated the keeping qualities of the putrescible material. This demonstration was the gravestone of the "theory of spontaneous generation," and the foundation of the latter work in Bacteriology. Like Pasteur, if we are to accomplish much along sanitary lines, we must have results to back up our theories. For example, if Hypo-chlorite is an efficient sterilizer, we must see a reduction in water-borne typhoid infection; in other words, we must look to our death rate reduction; with that proof in hand, we need little else. Now, as a matter of fact, Hypo-chlorite is a good disinfectant. Yet, until it was used in fairly large quantities, .6 parts per million, no appreciable effect was shown on Toronto's typhoid rate. Now, laboratory experiments would indicate that the use of 0.6 parts of available chlorine was unnecessary, and that 0.35 parts would be just as effective; but the practical demonstration showed very different results. Whether this was due to lack of data or insufficient measurements of water consumption, the author is not aware, but the facts are as stated. Hence

in carrying on disinfection experiments, one must not place too great confidence upon the laboratory side, except as indicators. The place to look for the effect of your operations is on your sheets showing presence of typhoid, cholera, and other water-carried infections. You have had good reason to know that 0.6 parts available chlorine impart a very objectionable taste to the water. It is this objectionable feature, in connection with disinfection of water supply, that brings us back to our original subject.

If we can not readily sterilize without objectionable tastes a highly polluted drinking water, then we must get after the causes of this pollution and **disinfect** it in such manner that subsequent dilutions will remove all traces of the objectionable tasting disinfectant used.

Slow sand filters have done, and are doing, splendid work, but they are rather expensive to operate when high degrees of bacterial purification are required. Especially is this true where a lake water, such as that of Lake Ontario, is used, which carries a very fine sand in suspension during storms. The water when in this condition may plug a filter up in three or four hours. Then it becomes a race to keep enough filters clean to supply filtered water to the community. If the water was known to be fairly safe (i.e., all large polluting streams disinfected), filters of different size sand could be adopted which would lessen the frequency of cleaning, and allow the use of various mechanical devices to assist in removing the clogging surface—devices which, under ordinary requirements of filters, are prohibited because they either remove too much sand or else remove too much of the fine sand used in the filter bed.

Of course, we cannot provide for all the various agencies by which pollution occurs, but we can at least get after those which are so apparent as sewage effluents. Gentlemen, you and I are the men that must see to it. If we who possess the knowledge of the evil and the cure, do not agitate and insist on its use, then who will ? We surely cannot leave it to some happy shots of the reporters of our daily papers—for with conditions varying as they do in different places, the remedy must vary also. There is no cure-all, as some of our political newspapers would have us believe. There must be careful investigation, the judicious use of research laboratories and scientific epidemiological field work, not only in one community, but in all. Our municipal Boards of Health are trying to do what they can with inefficient and under-equipped laboratories, but without the backing of the men who ought to know—the doctors, chemists and engineers—how can they go to the electors and councils to ask for the necessary funds ? Gentlemen, you may not care to put your life into sanitary work, but you can, and ought to, at least keep in touch with it and give it your scientific approval when circum-

stances permit, so that the public will at least know upon whose shoulders the responsibility lies.

In examining the results of the English analysis of sewage and sewage effluents, one is astonished to see the confidence with which systems are advanced upon the results of weekly and monthly analyses. It is only recently in our Canadian Engineer we had published a lengthy recommendation of the De-Clor process. Their experimental plant was in operation for twenty-one weeks, and in that time only twenty-one samples were taken. Does that not strike you as strange ?

The article lays special emphasis on the removal of B. Coli, so that it occurs only in 100 c.c. sample in the effluent, whereas in the prefiltered water it was present in 1-10 c.c. samples (i.e., a removal of 999 in 1,000) the bacterial count only showed a removal of general bacteria 885 in 1,000. Such results as these call for inquiry as to whether the removal of B. Coli is greater than for general water bacteria. The experiments at Mass. Institute of Technology indicate that it is about the same, and, if anything, a trifle lower, I want you to notice this point because it was further illustrated last fall by some rather curious results which came to my notice. The City Hall were making Bacterial analyses every second day, I believe, on tap water to detect B. Coli —sewage contamination. The Experimental Station was making analyses three times each day for purposes in connection with some experimental filters. Now, while the average of the every two-day set of analyses was not unlike that of the city for those days, the average of the three analyses a day was altogether different and showed heavy contamination. I am using this only by way of illustration of the point in question, namely, the value of frequency of analysis. It certainly makes a difference in bacterial work, and unless we, as scientifically trained men, know these things and, by knowing them, modify public opinion, a great amount of money is to be wasted in costly and inefficient apparatus. Remember, I am not saying the De-Chor process is inefficient—in fact, I like the idea. I am only saying that the published test was not extensive enough and somewhat misleading.

In sewage disposal there is, as a rule, two outstanding problems. (1) Disposal of trade refuse; (2) Disposal of domestic and factory sewage.

Now, there is no good reason why that trade refuse item should not be fought out with the manufacturers. Trade refuse is industrial waste. Take, for example, an instance in our own city here—that of the Harris Abattoir plant. At one time there was such a nuisance from their operations that the City Fathers, I believe, gave them notice to either remove the nuisance or shut down. They removed the nuisance and made a profit out of the waste. Now we have nothing entering our sewers from this plant save fluids from which even the grease that comes

from washing the floors has been extracted. What they have done under splendid management can be done by any other similar plant under equally efficient management.

With many other industrial wastes the problem is as yet unsolved, leaving splendid opportunities for research work under the direction of our faculty and among our graduates. Once the problem of trade wastes in a given centre has been partly solved it becomes a simpler matter to handle and purify the Domestic Sewage.

At present we have many processes for nitrifying sewage. From sewage farms and intermittent filter plants under proper management come splendid statistics, the sludge is digested, the effluent is clear and stable, only requiring disinfection as a final touch.

The question to which I would like to draw your attention particularly is still in the embryonic form as yet, but I bring it rather as a student to students, since it seems to me to be full of possibilities, especially for our Great Lake cities. I think we are generally agreed that in this enlightened age disinfection is a necessary feature of all sewage disposal problems. (1) Because it is not so very expensive; (2) The benefits to be derived are very great indeed in proportion to the expense.

Assuming disinfection necessary, can we not do away with this laborious nitrification, where large bodies of water are available for dilution ? If no process of purification and no disinfection is used, then we get conditions such as we have in our shameful Toronto Bay. This is not sanitary, nor is it a credit to any community in this twentieth century. Suppose we remove the suspended solids present in sewage by some process of sedimentation or chemical precipitation and then disinfect the effluent, will the effluent be stable in dilution ? That is the question. In the present paper I only wish to call to your attention some of the outstanding facts.

(1) We are seeking disinfection, not absolute sterilization.

(2) For stability, such that further putrification, if any, will take place only in aerobic conditions.

Disinfection is limited to the removal of pathogenic organisms. Of course, in process of doing this, we remove some 99.9 per cent. of the saprophitic bacteria, normally found in purtresible solutions, at the same time. Dunbar (1908) claims—and is no doubt right to within certain limits—" that by far the larger percentage of pathogenic micro-organisms are enclosed in gelatinous masses and attached to suspended matter." It, of course, is dependent upon the grade and rate of flow in your sewers whether these conditions exist at the disposal works.—" Hence any process which removes suspended matter removes also a large percentage of the pathogenic bacteria at the same time." " In some experiments on the removal of suspended matter in Hamburg River water, a removal of 30 per cent. of suspended matter

gave a corresponding removal of bacteria, and this would be much more so in case of pathogenic bacteria in sewage." Some experiments of our own with Garrison Creek sewage have failed to show such good results. This sewer is laid on a considerable grade and has a velocity of between ten and fifteen feet per second, so that sufficient disturbance is created to largely remove bacteria from any such attachments. However, our experiments have hardly been extensive enough to speak dogmatically as yet. There is no doubt that in chemical precipitation, where the coagulants are of a colloidal nature, some good results should be obtained in removing a considerable percentage of pathogenic bacteria. Generally speaking, pathogenic bacteria may be expected to be more sensitive to disinfection than the saprophitic forms.

One may raise the question of operation of disinfection upon bacteria in spore formation. Fortunately, very few pathogenic bacteria are spore formers, and sewage is not a media in which spore formation is likely to occur if it has not already taken place. There is one, however, that may be mentioned. That is Enteriditas Sporogenes, a bacterium which some investigators claim gives rise to Diarrhoea, especially when present in milk given to young infants. This form is almost always present in sewage, and gives a fermentation reaction similar to B. Coli. The odors, however, are entirely different. This form has been recovered from sterilized sewage—by sterilization I mean disinfection a removal of 99.99 per cent. of bacteria, say a count of 1,000,000 being reduced to 200 and 186—which is a practical possibility) so that we have reason to believe it is more resistant than normal to chlorine. It is an anaerobic bacterium, and this is no doubt why it has been overlooked. If we were to take a known positive sample and inoculate eight fermentation tubes, we might only get four or five positives to show up, due possibly to the fact that anaerobic conditions varied in the several fermentation tubes. However, this is a little aside from the general question, where there is every reason to believe that forms such as B. Typhoid are entirely killed out, and they are the ones to which most attention has been directed.

In some experiments of our own, 1.2 parts per million A. Chlorine served to kill out one million bacteria (suspended in water) so that the water became sterile in 55 minutes. Of course, organic matter has an effect on chlorine usually from eight to ten parts per million are required to practically sterilize Garrison Creek sewage in one hour. These results are borne out also by the work of Earle B. Phelp at Boston some few years ago (1906). I think we may justly assume that the pathogenic bacteria are almost entirely removed, especially where sedimentation or fine screening have been used previous to disinfection. It is worth nothing that H_2S reacts readily with chlorine. H_2S is not as a rule present in raw sewage except as a trade waste from

tanneries. But it is very much present in septic effluents—due to the decompositions of the proteids present, no doubt. Hence it is more economical to add chlorine to raw sewage than to septic tank. There are other reasons also why disinfection is preferable before septic treatment, such as the growth of anaerobic bacteria, etc. Septic treatment is, of course, unnecessary where we

Water		Sewage 1-10 dilution
Chlorine	3 to 10	6.5 to 11.5
Nitrates	.43 to 4.95	Raw Sewage .04 and less Nitrified " 0.3 to 3.0
Nitrites	.0135 and less	R. Sewage .01 and less N. Sewage .3
Free Ammonia	.063 to .009	R. Sewage 3.9 to 1.0 N. Sewage .19 to .01
Album Ammonia	.066 to .007	R. Sewage .65 to .01 N. Sewage .01 and less

NOTE.—Values in Table a little high for sewage and a little low for river water.

are using sedimentation tanks, and has, I think, been generally abandoned in favor of them, where large plants have been installed. Before leaving disinfection, let us remember one thing more, that is, that the chlorine deodorizes the sewage, so that if it be discharged two hours after disinfection we have (1) no odor, or, at least, very little, (2) the bacterial count per cc. varying from 100 to 500.

If you will notice the accompanying table, some must observe that sewage in dilutions of 1-10 shows very little worse than a normal river water. It has, in fact, been offered to some English investigators as pure water. I do not recommend it myself without thorough disinfection, which they overlooked without serious consequences.

Having noticed the constituents of a dilute disinfected sewage, we may turn to its possible stability.

(1) We know that even this dilute sewage will serve to support high bacterial growths, but experiments have only been made at laboratory temperatures, that is, 18° C. and 37° C. Now, the normal for Lake Ontario is about 7.5° C. to 9° C. in summer, except, for surface waters, which may run to 16° C. With them, however, we have storms, and consequently higher dilutions. Then again these subsequent growths must take place in an aerobic media. In this connection, I would like to call your attention to several theories with regard to putrifaction. (1) A known fact is that obnoxious putrifaction takes place only in media where the supply of oxygen is exhausted, when we have such productions as H_2S and NH_3 formed, which otherwise becomes SO_4 radicals and nitrates. (2) These operations only take place due to very high bacterial counts. Alfred Fischer

(1900) states in his work, "The Structure and Functions of Bacteria," the following (see pages 99 and 100):

"Putrefaction is a purely biochemical process, and can only take place when the fundamental conditions for all vital action are fulfilled. If the temperature sinks below a certain point, organic substances cannot putrify, as was well shown by the frozen Siberian mammoths. When discovered, their flesh was so little changed that it was eaten by the hunters' dogs; yet it must have lain in nature's refrigerators for countless centuries. In all methods of preservation the fundamental principle is the same, namely, to create such conditions that bacteria cannot live; for putrefaction—the splitting-up of the nitrogenous constituents of organic matter—is the work of bacteria, and of bacteria alone.

"The list of putrefactive products is far from being complete, for even the qualitative investigation of the processes is still unfinished; quantitative analyses are at present impossible. We do not know, for instance, what determines the predominance of one or the other intermediate product. The effects of the presence of oxygen are somewhat better understood. If air have free access, putrefaction may go on without any odor at all, the evil-smelling gases (NH_3 and H_2S for example) being oxidized at once to form nitrates and sulphates. Aerobic bacteria, too, bring about this mineralization of organic matter, such as the nitre and sulphur bacteria. Moreover, when air is circulating freely there is no accumulation of intermediate products such as skatol or indol. This kind of decomposition proceeding without offensive smell, may be termed decay, as distinguished from putrefaction."

Now, do you see where we have arrived at in our theorizing? If we kill out those forms causing anaerobic putrefaction by disinfection and change of media so that only aerobic decay can take place, have we not arrived at a condition similar to the ordinary respiration of plants and animals, where energy is obtained from the combustion of a few molecules instead of that present in septic tanks, where the energy is derived from the incomplete combustion of many molecules?

Gentlemen, it seems to me we have a theory here that is worthy of investigation, and I hope at some future date to give you some of the experiments that will be adopted in trying it out, and our results therefrom.

AERIAL NAVIGATION.

CHARLES H. MITCHELL, C.E.

When asked by the President of the Engineering Society of Toronto University to prepare a paper for the Society on the progress of aerial navigation the writer was inclined to seek an excuse in press of other work. It occurred to him, however, that it was due the Society about this time to present a review of the development and progress of aerial navigation, as arising out of his paper on "Aerial Mechanical Flight," read before the same Society in January, 1895, and printed in Vol. 8 of the Society's proceedings. This paper was a resume of the science and art of aerial mechanical flight—if art it was—up to that time, and was compiled from all the sources of information then obtainable, which were scarce, indeed.

The principles enunciated in this early paper are now of especial interest in the light of the intervening history of aerial navigation and of the recent extraordinary successful operations of "heavier than air machines." The chances of the commercial development of mechanical aeroplane flying machines based upon the "everyday principles underlying the kite, the boomerang or the skater on thin ice" were then carefully studied and it was stated that "the perfection of aerial flight will come gradually, as did other perfected inventions which have revolutionized the whole world. We cannot look for any one man to thoroughly solve the problem, but it will be evolved from many sources, and these will at last contribute to the one long desired end." To still further quote this early academic brochure of sixteen years ago, the following significant enumeration of the requisites for a flying machine was made:—

"1. Its various parts and members must be of the lightest construction compatible with strength and stiffness, and the factor of safety must be large.

2. Its general configuration must be economical for space and convenience and present the least possible resistance to the air.

3. It must be capable of rising gently but swiftly and supporting itself in the air in storm or calm for a length of sion."

4. It must have stability and be incapable of upsetting.

5. Should be easily steered in any direction.

6. Provided with a means of rapid and powerful propulsion.

And the sentence is added: "This enumeration may appear highly idealistic, but the practical possibility is much clearer than is generally supposed."

That was sixteen years ago. It is needless to now draw attention to the present-day parallels of these requisites, or to

ask to what extent they are fulfilled in to-day's aeroplane practice. But the art is only in its infancy, and who knows what another sixteen years will bring about? This is perhaps even harder to conceive when the progress of building and flying aeroplanes during the past three years is considered in the course of the general evolution.

The purpose of this paper is to briefly outline the development of aerial navigation, especially in mechanical flight, during the past few years, and to present some slight description of present-day uses and possibilities—particularly from a practical viewpoint.

Although primarily dealing with flying machines heavier than air, it is interesting to note historically the singular parallel evolution of the dirigible balloon which has almost kept pace with that of the aeroplane.

It is convenient to distinguish between the various classes of air craft according to their nature and functions. The most recent classification is about as follows:—

I. Craft lighter than air: "Aerostatic."

1. Kites—
    - Simple.
    - Man-lifting kites.
    - Balloon kites.
2. Balloons—
    - Captive.
    - Free.
3. Dirigible balloons—
    - Non-rigid types.
    - Semi-rigid types.
    - Rigid types.

II. Craft heavier than air: "Aerodynamic."

1. Aeroplanes—
    - Monoplanes.
    - Bi-planes.
2. Helicopteres—
    - Vertical lift machines.
3. Combined dirigibles and aeroplanes.

While the main attention herein is given to dirigible balloons and to craft which are heavier than air, a few words may be said in passing with regard to the employment of kites and captive balloons, especially in warfare.

Kites.

Kites have been developed considerably in the British Army and Navy and on account of their cheapness and compact form for transportation, have produced very good results

in the field. It appears that man-lifting kites have been very successfully operated from ships and lately Major Baden-Powell has worked out a system for using explosive kites against air ships. The man-lifting balloon kite, which is a combination of a small gas-bag and a second bag open freely to the air, has been developed considerably by the Germans, and has been used extensively in their manoeuvres.

Captive Balloons.

The captive balloon is, of course, familiar to all for purposes of general observation, signalling, directing gun fire and, recently, at sea, for the detection of submarine attack. It would appear that notwithstanding the rapid introduction of aeroplanes and dirigibles the captive balloon and kite will still remain a useful means of observation both on land and sea for some time to come.

Dirigible Balloons.

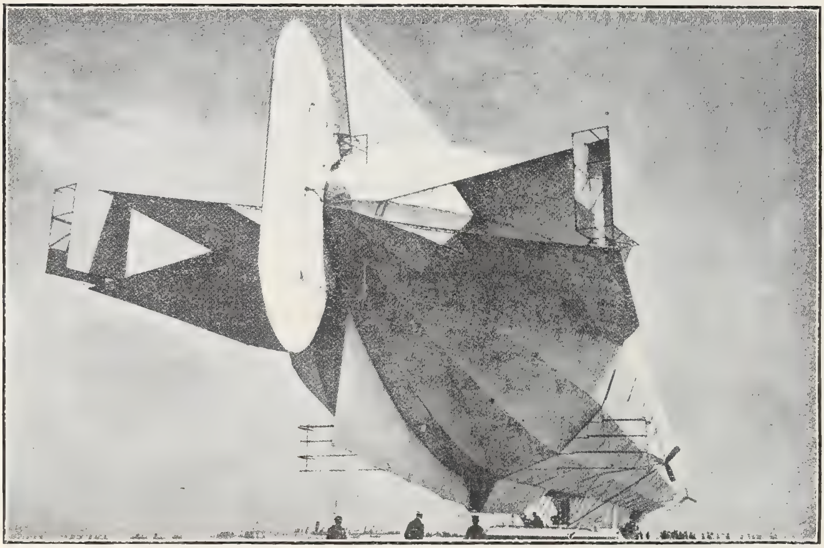
Although many early attempts were made to propel balloons, no real success was made until the recent development of the light, but powerful automobile engine. After types of these engines became established their various applications to aerial navigation was most quickly taken advantage of with the recent remarkable results.

A German named Schwartz is credited with driving the first rigid airship with a gasoline motor, which was 12 h.p. His ship, however, was wrecked after several successful trials. This was in 1897. In 1898 Count Zeppelin came on the scene with a rigid type, having an aluminum frame and gas bags between an inner and outer envelope—built in gas-proof compartments as it were. It was a large vessel 300 feet long, driven with two gasoline motors, each geared to two propellers. Though he secured a still air speed of 16 miles per hour, there were many defects found and the attempt was temporarily given up, but patriotic Germans came forward in these discouraging days with money to build a second.

In 1902 Santos Dumont, in a non-rigid cigar-shaped balloon, performed the first really signal dirigible feat by circling around the Eiffel Tower in Paris, winning a prize of $20,000. This year also saw the first work of the Lebaudy brothers, who brought out a semi-rigid type by which the bending and buckling strains are taken off the gas envelope by a metallic keel; this was propelled by a 35 h.p. motor. This vessel was wrecked in 1903 after doing some 50 successful trips, the longest being 62 miles at 22 miles per hour average. But this was the start of the great French airship fleet, for shortly afterwards the French Army adopted a similar type, and after several successful ships, the "Patrie" was launched in 1906, and in 1907 was used in the manoeuvres, doing a trip from Paris to the frontier,

a distance of 150 miles, at 22 miles per hour. Shortly after, however, the "Patrie" was wrenched from her moorings, blown away and lost on the North Atlantic. This was followed by the "Republique," the largest of the semi-rigid type yet built, having cylindrical stablizing gas bags at the stem; she was 210 feet long, had an 80 h.p. engine, a range of action of 500 miles and could carry nine men. In 1908 she did 147 miles at 21 miles per hour.

In the meantime Count Zeppelin had succeeded in his second ship, which was tested in 1906, but was wrecked by a storm. This was shortly followed by a third, and in 1908, by a fourth much more powerful than its predecessors. This "Zeppelin IV." was built on special specifications of carrying power,



ZEPPELIN IV. DIRIGIBLE BALLOON
Courtesy John Lane Co., from "Airships in Peace and War," *Hearne.*

speed, endurance; she was 446 feet long, had two Mercedes motors of 120 h.p. each, carried a crew of 18 men, and her estimated range of action was 800 miles. One special feature was the arrangement of the 16 independent gas bags within the envelope. This airship was tried out in numerous preparatory short trips before the official government trial, by which the airship was to carry 16 men and be capable of travelling for 24 hours. In one of these trials in June, 1908, "Zeppelin IV." went across the Alps, doing in 12 hours a total of 270 miles at an average speed of 22 miles. In August of the same year an eventful attempt in which the ship again travelled a distance of 270 miles at an average of 24 miles per hour, resulted in its com-

plete wreck by explosion and fire; this accident could not have occurred, it is said, had there been apparatus for properly anchoring the vessel to the ground while at rest.

The same year two other successful German dirigible airships, the "Gross" and the "Parseval," both military ships, made their appearance, the former remaining aloft for 13 hours, and reaching an altitude of 4,000 feet, and the latter for 12 hours.

In 1909 dirigible airships of the foregoing types performed many successful and extraordinary flights. France put four notable new ships out—similar to the "Republique." The latter vessel, while going to the French Army manoeuvres, met with an accident which was promptly repaired by the Airship Corps of their army in the field under virtual war conditions. This field repair marked a new step in progress. The ship was used in the manoeuvres and did very useful intelligence work, particularly discovering a wide turning movement of its opponents. The "Republique" was completely wrecked by the breaking of a steel propeller blade in September, and the crew of four killed.

In Germany 1909 saw remarkable performances of the new Zeppelin's, the "Gross" and the "Parseval." The former made a round trip of 800 miles, including the sailing over Berlin, and this placed the Zeppelin far ahead of all rivals. The work of four airships at the German military manoeuvres that year was extensive, and though no information was given out it is known from attaches' reports that exceedingly useful work was accomplished. One interesting operation was a night attack against the fortress of Ehrenbreitstein on the Rhine near Coblenz, in which several ships were employed.

During the year 1909 a new Italian airship in a run of 190 miles made 27 miles per hour average, which captured the high speed record.

The year 1910 produced some new records of particular interest, and there were several notable flights of historic value. Wellman made a courageous attempt to cross the Atlantic, starting near Boston. His arrangement, which he called an "equilibrator," which dragged in the water to stabilize the ship, nearly caused a fatal ending; as it was, the ship was blown about and out of its course by a fierce gale, and was finally abandoned about 200 miles at sea, the crew being taken off by a steamer under thrilling circumstances. The French dirigible, "Clement Bayard II.," made a remarkable flight from Paris to London on October 16th, doing 246 miles at an average of 41 miles per hour, with a crew of seven men. This airship is 251 feet long, 44 feet diameter, has two engines of 120 h.p. each, a range of 750 miles, and carrying a capacity of 20 men.

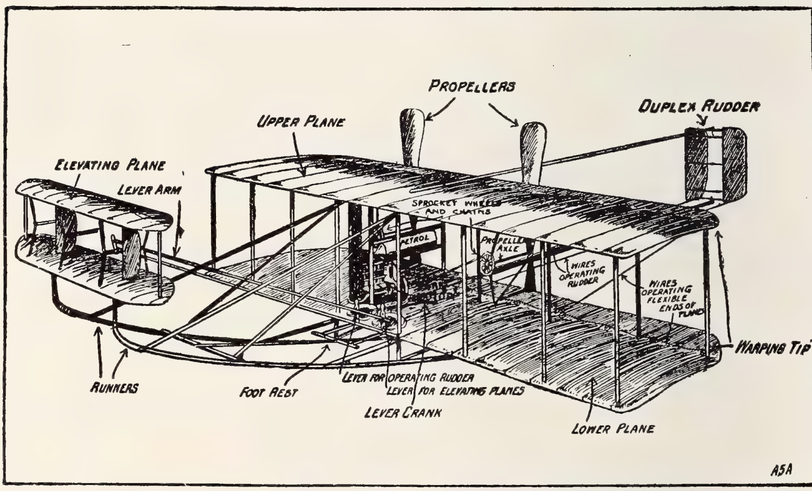
Dirigibles were used in the principal European Army manoeuvres in 1910, with varying success. In this connection

the great success of the British dirigible, the little "Beta," is of interest because of the plucky work of its commander. It is just announced that this airship, working near Aldershot this week, kept in touch by wireless during the whole of a trip of many miles from start to finish.

On February 7th, 1911, the German dirigible, "Gross IV.," was taken out for its first trial. It is 344 feet long and expected to be one of the fastest yet constructed, being capable of making 40 miles per hour. The British admiralty, however, has just now (February 18th) about completed a monster airship—the first aerial "Dreadnought"—at Barrow-in-Furness, 510 feet long, 48 feet diameter, and having 706,000 cubic feet capacity; eight cylinder motors, with three new type propellers are expected to drive the ship at 50 miles per hour.

Aeroplanes.

The perfecting and the employment of aeroplanes is much more recent than the similar progress with dirigible balloons.

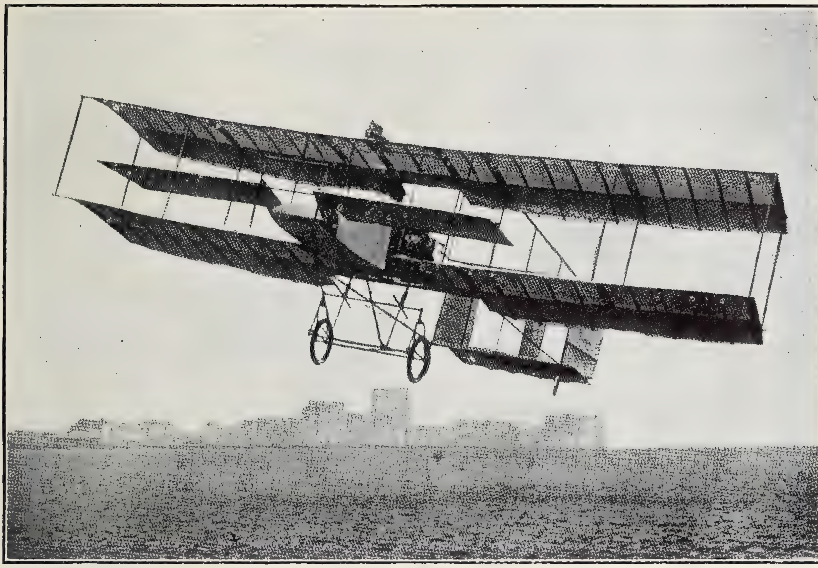


DIAGRAMMATIC VIEW OF WRIGHT BIPLANE
Courtesy John Lane Co., from "Airships in Peace and War," *Hearne.*

The early experimenting and research, however, commenced about 1892, and by 1896 there was considerable data and some experience accumulated with respect to bird-flight, gliding on air and laboratory aero-dynamics. The outstanding features of this period were the experiments with kites by Professor Langley in America, the construction of a steam-driven aeroplane by Sir Hiram Maxim in England, and the actual air-gliding by Lilienthal in Germany. With the latter's death and the great difficulties encountered by Maxim, progress almost ceased, and for a period of eight years the only work done was

quiet experimenting in seeking after suitable engines, propellers and forms for aeroplanes. Chief among these workers were the Wright brothers, who, for some years prior to 1904, were working with one and two-plane gilders in North Carolina at a place where among rolling sand dunes a steady wind was assured. In this work they were assisted on the technical side by the late Mr. Octave Chanute, an eminent consulting engineer of Chicago. In such a manner they became expert in the handling of their air craft.

At this period —1905—several forms of aeroplanes had become notable, and with the solution of the engine problem following closely on the development of the automobile engine.



FARMAN BIPLANE
Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

actual flights were accomplished. There remained, however, the perfecting of innumerable details and the gaining of experience and skill on the part of operators to attain the confidence, presence of mind, and almost intuitive quickness necessary to control a heavier than air machine in much the same way as the learning to ride a bicycle. These early experiments of either gliding or driving a plane against the air for a short distance were based upon the principles of soaring bird-flight or of the skater on thin ice.

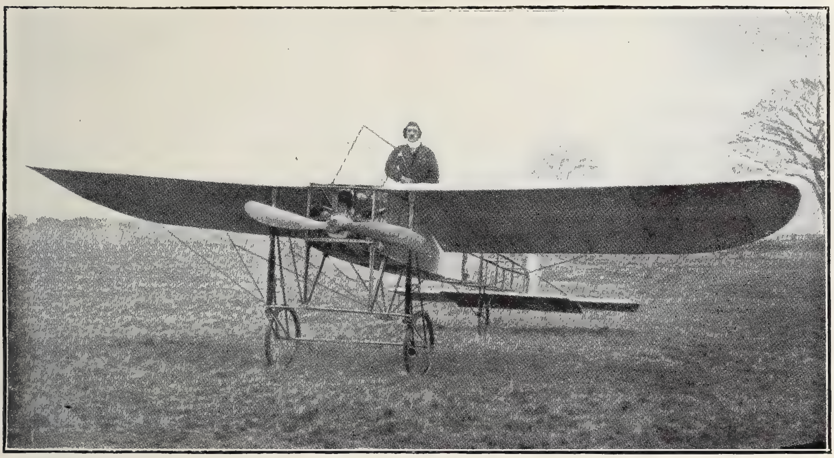
In 1905 the Wrights astonished the world with the announcement, without details, that their bi-plane machine had actually remained in the air for a half-hour, and later that they

CURTISS BIPLANE USED BY J. A. MCCURDY, '07, (TORONTO) Courtesy The Copp, Clark Co., from "Vehicles of the Air," *Lougheed.*

had flown 24 miles in 38 minutes. In other flights they had attained great speed, the greatest having been 38 miles per hour.

As the Wrights undoubtedly led the world in the development and operation of their aeroplane, there are several features of the machine deserving of special mention here. The frame was of hickory and the planes of strong fabric; the wing warping device on the corners of the planes, worked by wires over pulleys for balancing and facilitating turning, were especially novel. This flexure of planes in conjunction with vertical and horizontal rudders enabled the balance to be quickly —almost instinctively—made. By their long experience in these early days the Wrights became so dexterous that they were for some years far ahead of other aviators in their skill in flying. They showed that it was more in the man than in the machine that success lay.

In 1907 a new aviator, Farman, appeared in France, and



BLERIOT MONOPLANE

Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

he accomplished numerous short flights, up to a half-mile, in a bi-plane, known then as the "Voisin." His performances, however, were soon eclipsed by those of Delagrange, another Frenchman, who, in 1908, flew various distances up to 15 miles, done on September 6th. But this month of September, 1908, was destined to become notable in aviation, as the Wrights, one in Europe, and one at Fort Meyer, in the United States, were almost daily performing something new, the one breaking the record of the other. The performances comprised flights of over an hour by Orville Wright in America on September 9th and 12th; in the latter 45 miles were covered. Wilbur Wright in Europe on September 21st, flew one hour and a half, in

which 56 miles were done and on September 28th, he carried a passenger.

In October of 1908 Wilbur Wright, with a passenger, did 36 miles in 56 minutes, and Bleriot first appeared with his small monoplane, in which he did 3 miles in four minutes and a half.

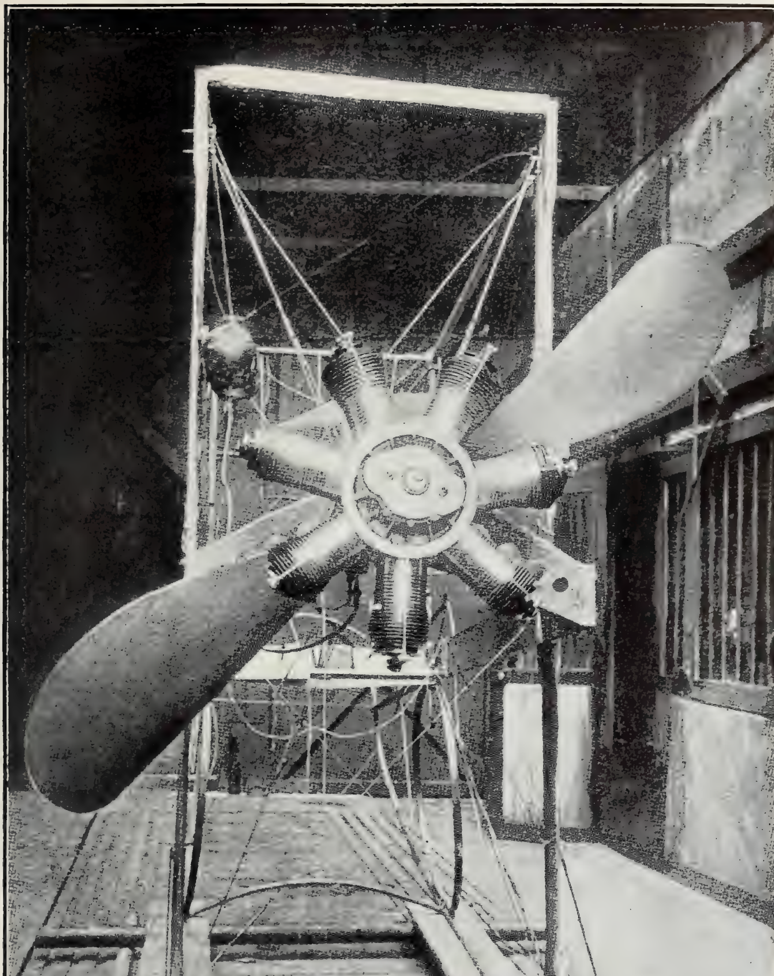
The year 1909 was notable in aeroplane performances as well as for dirigible balloons. Orville Wright carried a passenger 45 miles in one hour and thirteen minutes on July 22nd, and three days later the world was startled by the news that Bleriot had boldly crossed the English Channel in a small monoplane, 31 miles in 40 minutes. Then on August 26th, Latham, a new aviator, with an Antionette monoplane, flew 97 miles in 2 hours and 13 minutes, and the following day Farman, again to the front, with his bi-plane, broke all records by going 112 miles without a stop. Again on November 3rd, 1909, Farman in his own bi-plane with a Gnome motor, flew 145 miles in 4 hours and 18 minutes. Another significant performance by Farman was on August 28th, when he carried two passengers 6 miles in ten and a half minutes.

This year a second American aviator came prominently before the world; this was Curtiss who, in a bi-plane of his own design performed various feats, especially at the time of the Fulton celebration at New York. His machine, developed with the advice of Dr. Graham Bell, is, in general, similar to the Wrights, but instead of warping the ends of planes, he has small auxiliary planes at the outside ends between the two main ones; his manipulation is also interesting, as he employs the shoulders and swaying body in actuating the rudders for horizontal turning. It is in this type of machine (perfected in the Hammondsport Experiments) that J. A. D. McCurdy, of the class of 1907, Engineering, in Toronto University, is now doing such wonderful feats.

The year 1910 did not produce any extraordinarily long flights, but the altitude records were very much increased, about 7,000 feet being the highest. The various aviation meets, notably those at Belmont Park and Atlantic City, brought out results in control and handling of aeroplanes which prove beyond doubt that these machines are capable of various rapid manoeuvres far beyond the earlier expectations, and these are probably only the beginnings, so that we are justified in expecting wonderful results in stability, manoeuvre and carrying power within the next five years. Speeds were also much increased, especially with the monoplanes which are, of course, the fastest types; Morane, with a new Bleriot, flew 66 miles per hour at Rheims.

As examples of manoeuvre in 1910 two performances in America are notable. One was by Graham White, an English aviator, who flew over the City of Washington, alighted in the

street in front of the Navy Headquarters Building, made a call and rose again from the street and flew away again over the



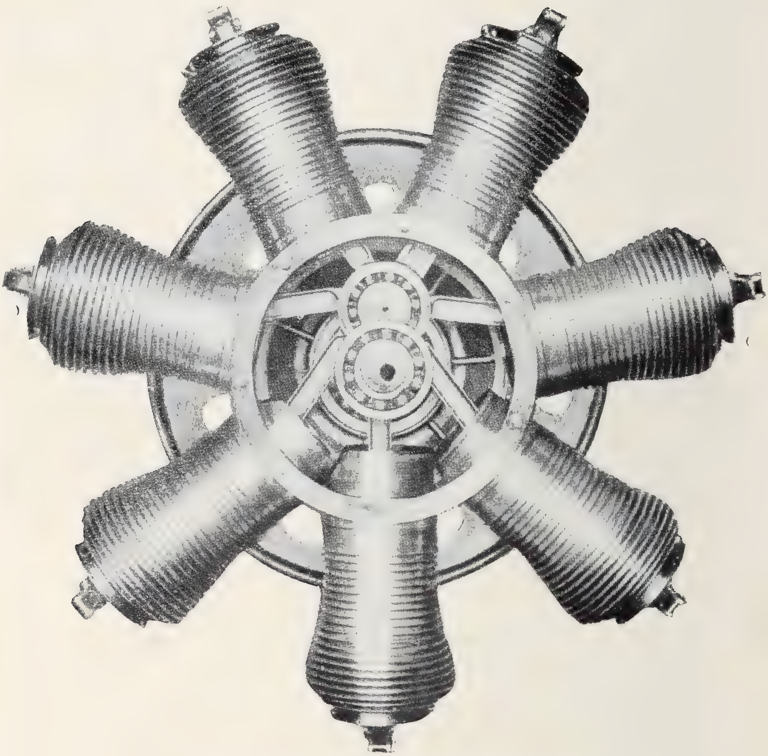
GNOME ENGINE AND PROPELLER
(THE WHOLE REVOLVES AS A FLYWHEEL)
Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer.*

city. The other was at Belmont Park, when an aviator, off to a false start on the race course, was recalled and suddenly

circled in a small radius around the judges and the announcement board, back to the track in front of the grand stand.

The flight of Chavez in a Bleriot monoplane over the Alps from Switzerland to Italy in September, 1910, is also notable with respect to manoeuvre, as in 25 miles and a rise of 3,000 feet, he encountered all kinds of vertical cross air currents and bitterly cold air off the snow-clad peaks.

It is likely that the next few years will produce aeroplanes of much greater carrying power as well as of greater manoeu-



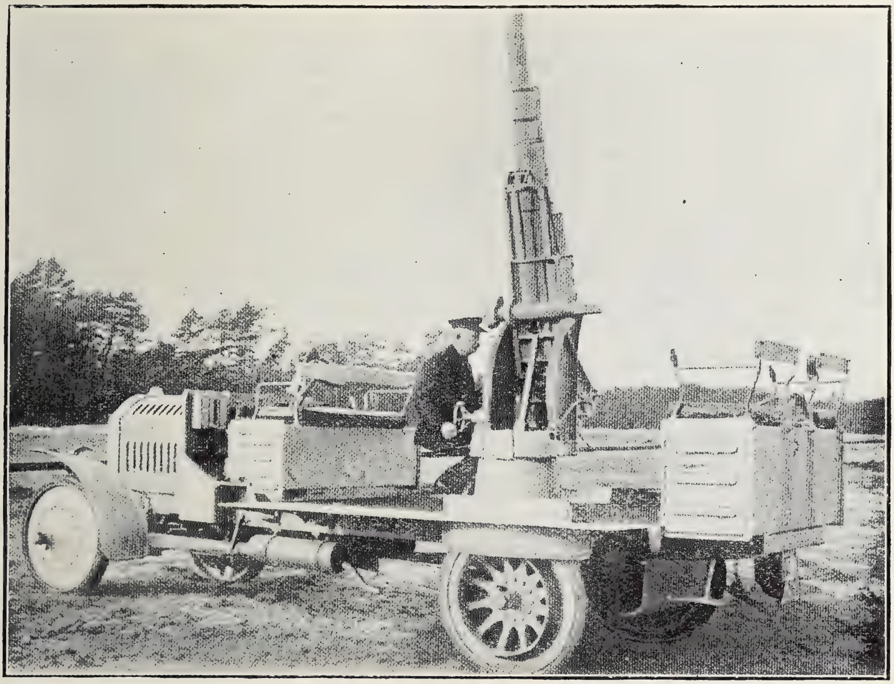
INTERIOR OF GNOME ENGINE

Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

vring capabilities. Increases of speeds are also to be expected, especially with the monoplanes. It was announced in 1910 that a new racing Bleriot had been built and was being secretly tried, in which speeds up to 75 miles per hour were expected. This type had ingenious wings, which could be flattened out in mid-air and contracted so that the machine could be speeded up while actually in flight.

Combination Types of Airships.

There is not much yet to be said respecting airships combining the features of balloons and aeroplanes. Several such arrangements have been built and tried, but not worked out over long courses. Vertical lifting machines have also been built, but as yet have not become practical. It is likely, however, that considerable progress will be made within the next few years along the combined lines, especially for meeting conditions where ascents and flights are required to be made irre-



GERMAN 3-INCH GUN FOR ATTACKING AIRSHIPS
Courtesy Crosby, Lockwood & Son, from "The Art of Aviation," *Brewer*.

spective of weather conditions, such as may be absolutely necessary in warfare.

There is no doubt that very shortly a vertical lifting "heavier than air" machine will be brought out, capable of standing stationary, or hovering over any point; this will probably combine the horizontal speed properties of the aeroplane.

A new combination of airship and hydro-plane is also beginning to appear, brought about by the necessity of aeroplanes alighting on or rising from water. Only last month Curtiss, in such a machine at San Diego, Cal., alighted on the water

alongside a U. S. warship, and after 15 minutes' visit, rose again from the same spot.

Feasibility of Aerial Navigation.

From the foregoing it is not only apparent that the navigation of the air is feasible by dirigibles and aeroplanes, but that as each year passes, with its improvements in types and increased skill in handling, aerial navigation will, before long, be as assured, and as universal as motoring on land or water. It is now only a question of a few years before dirigibles carrying cargoes of many tons, and aeroplanes carrying four or five people will be an established thing. The science will be then beyond the experimental stage and there will be many operators of all nationalities having the requisite experience and skill to actually navigate the air with ease, confidence and safety.

In view of the present state of the building and skill in flying, we are reasonably justified in expecting that in the next two years:—

Dirigible balloons will have a range of action of 1,000 miles, a speed of 40 miles per hour, and a carrying capacity of 4 tons.

Aeroplanes will have a range of action of 200 miles, a speed of 50 miles per hour, and a carrying capacity of 800 pounds.

Both classes of air craft will be capable of operation at will in any moderate wind, either with or against it.

If the foregoing results can be realized the successful permanent employment of such dirigible balloons and aeroplanes for military purposes is an absolute certainty because they are then brought into the category of practical fighting equipment of modern armies and marine navies.

Employment of Airships.

It is as yet premature to attempt any serious conjecture with regard to the ultimate employment of air-craft, either in extent or variety. While commercial uses may appear probable within the next few years military uses are already in sight and a discussion of the possible employment of air-craft for this purpose would be of interest.

Already, as noted, the great powers have been employing dirigibles and aeroplanes in connection with both army and navy manoeuvres. Just now comes the news that Germany will, in the 1911 manoeuvres to be held on the Baltic coast, use flying machines in connection with combined operations in which the battleship fleet will co-operate with their army corps in problems involving the landing of an army in coastal defence.

In those features of modern war, involving tactics and strategy, the employment of air-craft will entirely revolutionize the science. The application of mounted reconnaissance for

both tactical and strategical purposes can be applied equally well to aerial scouting with the addition that the range of action and the horizon will be very much increased.

The peculiar adaptation of dirigible balloons and aeroplanes is very marked; a few of these properties, especially for war operations, are as follows:—

1. Wide range of action is now obtainable.

2. Carrying capacity is sufficient for men and food, etc.

3. Speed is as fast as any land or sea travel without delays occasioned by latter.

4. Height of operation is such as to be clear of accurate effective gun fire.

5. Direct routes are available day or night, or in fogs (within limits).

6. Positions of altitude are most adapted for observation and signalling, and for locating submarine objects.

7. Air operations cannot be guarded against except with similar craft or by special terrestrial apparatus.

In adapting these various proven properties of airships and especially of aeroplanes, there are certain well-known uses which have already become apparent for military and general service; an enumeration of these follows:—

For Military Service.

1. Peace and war time reconnaissance, reporting and study of foreign countries, fortifications, harbors, etc.
2. Signalling and wireless telegraph purposes.
3. Carrying despatches.
4. Guards and patrols at frontiers and before an army.
5. Preventing an enemy's observation and screening operations from view.
6. Directing and observing artillery fire.
7. Destroying stores and raiding harbors, fortresses and cities.
8. Surprise or night attacks.
9. Discovering and destroying submarines and mines.
10. In conjunction with general engagements on land or sea.

For Commercial Service.

11. Despatch carrying for emergency purposes.
12. Rapid express transport or mail service.
13. Passenger service of rapid and luxurious character.
14. Exploration in inaccessible or far-distant countries.
15. Scientific research.
16. Rescue purposes at sea.
17. Recreation, sporting and spectacular.

The commercial use of aeroplanes, for instance, while as yet

conjectural, affords quite as much variety and opportunity for development in types and their employment as does the military use. It must be remembered, however, that in order to adapt air-craft to commercial use they must meet the powerful competition of the present forms of land travel and the opposition of those commercial organizations operating the land and water transportation utilities. On the other hand, because of the fact that all aerial travel can be made on routes direct and unhampered, and that travel routes have three dimensions in which to operate, the ultimate success of aerial navigation can be fully expected though it may take a stretch of the imagination at present.

As a case in point illustrating commercial use the following comparison in time of the employment of an aeroplane in competition with a railway train, and a motor car, is suggested, it being assumed that a doctor in London is suddenly called upon to make a special emergency call in the country 100 miles distant by bee-line, 120 miles distant by rail, with nearest station four miles, and 140 miles by road. This outline is an extract from "Airships in Peace and in War," by R. P. Hearne:—

SPECIAL TRAIN		SPECIAL MOTOR CAR		SPECIAL AEROPLANE	
Getting ready	30	Getting ready	10	Getting ready	15
Passengers' time to starting point	15	Journey to doctor's door	15	Passengers' time to starting point	15
Time getting clear of London	10	Delay in getting clear of London	35		
120 miles at 50 miles per hour	145	130 miles at 35 miles per hour	222	100 miles at 60 miles per hour	100
From station to house	20	Delay in getting to house	8	Landing and getting to house	20
Minutes	220	Minutes	290	Minutes	150

Operation of Air-Craft.

As to the probable methods of operation of the various types of airships much can be said and conjectured, but until a good many features of endurance, reliability, speed and handling are tried out, it is not likely that definite conclusions can be reached. Even with the more stable types of airship, and in the short years of trial up to the present, the accidents which occurred, and the loss of life, have been appalling. In the year 1910 the number of famous aviators who have lost their lives has been most deplorable, but unfortunately it is to be reasonably expected that there will be still many more accidents and loss of life in the strife for the mastery of the air before the art of building ships and flying them will become fixed like other similar operations. As, in the nature of events, the "heavier than air" machine is undoubtedly destined to become the ultimate means of aerial locomotion, it is evident that in its development there

must yet be years of trial, success and failure before final definite success is attained.

The various difficulties and dangers which have already been encountered are really at the present time increasing rather than being reduced, for as the art advances and navigators become bolder, the hazards taken are greater. For instance, at one time it was thought that navigation in wind and rain storms, fogs, etc., was impossible; now we find ascents being frequently made under such weather conditions, as, for example, when Latham in 1909 went 75 miles per hour in a gale at Blackpool in his Antoinette monoplane. Fires and explosions on dirigible balloons are a great menace—instance the disaster to Zeppelin IV.—possibly lightning would come also in this category. Breakdown of engine or of propellers or steering gear, etc., in aeroplanes is almost fatal, especially in high flying unless the aviator is successful in righting the machine and gliding to earth without overturning; nearly all fatal aeroplane accidents have been due to this mishap though ehere are several notable examples of the machine being brought down safely—instance, Curtiss at Atlantic City in 1910. Loss of fuel either by leakage, accident or use is another danger. Collision with buildings, trees or other craft is also to be reckoned with.

Organization and Training of Aerial Corps.

It is not at all surprising that, with all this progress and the swift application of aerial navigation to uses of warfare as the first employment, the nations are seriously organizing and training aerial corps. Next to the development of the machine and equipment, the training of experienced expert aviators and aeronauts is paramount. This is harder than it seems for the means of training are limited, are highly expensive, and often produce discouraging results, as have been experienced the past 3 years. The present year, however, sees all the great powers appropriating large sums in their estimates for this purpose. The German Government has planned very large expenditures, and it is now unofficially announced that eleven German universities will, during the summer of 1911, institute lectures on aeronautics and the mechanical principles underlying the flying machine and its operation. The United States has authorized very considerable expenditures in training, and the news just comes that the National Guard of California has authorized the formation of an aerial corps in connection with the Coast Artillery. It is interesting to notice that the British Army estimates for 1911 include a half-million dollars for new dirigibles and aeroplanes and for the expenses of an aeronautic staff. It is stated in newspaper despatches that the British Army will have five dirigible balloons and five aeroplanes available for use the coming summer.

As to training, especially in aeroplane operation, the work

of Mr. Curtiss at San Francisco for the U. S. Army and Navy is of special note, as indicating how he instructs novices to handle a machine. The first operation after mastering the mechanism of machine and engine is to take short hops or jumps of from 50 to 200 feet, but not higher than 20 feet. Then longer jumps are allowed, and then a low flight, skimming the surface or "grass-cutting" as it is called. After this recruits are allowed to fly and manoeuvre, but always over level ground and close to it. Reports say that practical and athletic officers who are accustomed to motoring and sailing learn very rapidly and safely.

Toronto, March 1st, 1911.

DETAILS OF AEROPLANE TYPES

(As in use in 1909 and 1910.)

CHARACTERISTICS	MONOPLANES		BIPLANES			
	BLERIOT	ANTIONETTE	WRIGHT	FARMAN	VOISIN	CURTISS
AEROPLANES:—						
Span, feet	28	46	40	33	38	29
Area, sq.ft.	150	377	540	430	540	250
WEIGHT:—(No Pilot)						
Total, pounds	462	1045	880	990	1100	550
Per sq.ft. of Plane	3.08	2.77	1.63	2.30	2.04	2.20
MOTOR:—						
Type—Cylinders	3	8	4	4	8	8
Revs. per min.	1200	1100	1500	1300	1200	1200
Power in H.P.	24	50	30	50	50	30
Sq.ft. Area per H.P.	6.25	7.50	18.0	8.6	10.8	8.3
Weight per H.P. per sq. ft. Area	0.13	00.5	0.05	0.04	0.04	0.07
PROPELLER:—						
No. of blades	2	2	2 of 2	2	2	2
Material	wood	steel	wood	wood	steel	steel
Diameter	6ft. 9in.	7ft.0in.	8ft.0in.	8ft.6in.	8ft.6in.	6ft.0in.
Speed	1200	1100	450	1300	1200	1200
SPEED:—						
Miles per hour in still air: Average	40	38	39	41	37	48

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EDITORIAL

VACATION AND VACATION WORK.

During the last week in April some seven hundred and eighty-five men, undergraduates of this Faculty, their Spring examinations over, will be ready for a Summer's vacation. The many methods of spending it that are in mind about this time of year do not in all cases coincide with the opinions as to how it might be spent to best advantage. Professionally, a man can do no better than begin, on May 1st, and abandon about September 25th, a system of labor which will yield him the greatest possible grounding and advancement in his chosen field of engineering. The advisability of such procedure, even in the most healthful, out-of-door branches, might not pass criticism, and a shorter term might be recommended, and to them who will find themselves engaged in foundry or machine shop, practice in underground or chemical

work, it is obvious that an intermission between the clash with the April cavalcade of technical disturbances, and the setting out to vacation work, is also in the interests of young engineers.

Graduation in mining requires that the students shall have at least six months' practical experience in mining, metallurgy, or geology, " for which they must receive regular wages." In the departments of mechanical engineering and electrical engineering, the minimum is set at eight months. These are minimum quantities, and, naturally, the maximum is undefined, the inference being that the requisition is based on the stable assumption that as much practical work as possible should be worked into the university course in engineering. This doesn't include a spattering book canvass of a municipality, or a Summer's cruise on a passenger steamer as waiter. These occupations are acknowledged means of remuneration to students of various other faculties. But if the engineering student has a primary view to reimburse his saving bank, he will best do so by engaging in, and adhering to, the work with which he hopes to fill out a certificate form, whether his department calls for it or not. In other words, the monetary value of vacation work in engineering is, generally speaking, much in advance of any other to which the average student is obliged to turn his hand. Moreover, the advantage of experience in the proper field is obvious.

The undergraduate in civil engineering learns early in his course that experience in the field is a very necessary adjunct if he hopes to derive full benefit. A clause in the calendar requiring a certificate of experience is evidently unnecessary. The more practical experience acquired early in the course, the more valuable the course is to him, and the higher will be the salary that the profession will find him capable of earning upon graduation, is his conception of the problem.

Then again, there are other reasons why the college graduate is not prepared for his place in the world upon leaving college, unless he is already equipped with knowledge gained through practice. For example, the most efficient graduate is one who, during his four years at college, has had a good taste of the work before him when he leaves, not altogether because of the knowledge he has gained by applying technical formulae to that work, but because of what he has learned of life as lived among engineers, and of the problems of discipline that have confronted him. The more he obtains of it, the greater will be his directive force, and the more effective will he prove himself, by his early submission to ordinary, every-day engineering discipline. This is as necessary to the man who is going to be a successful engineer, as financial means is to the man who choses to spend the coming vacation at Newport or Rockaway.

THE ELECTRICAL CLUB.

Though of comparatively recent origin, the Club has, since its inception, held an important place among the student organizations. A few words regarding its history and aims may not be out of place.

It was founded during the term 1906-07, primarily for the purpose of encouraging public speaking among engineering students, by the presentation and discussion of technical papers. Its membership was limited to third and fourth year Mechanical and Electrical students, and the fact that it has flourished in spite of its limited membership is an indication that it is meeting a need of the students. The first president was W. MacLachlan. Since then the presidents have been: 1907-08, F. R. Ewart; 1908-09, C. L. Gulley; 1909-10, C. J. Porter; 1910-11, W. P. Dobson.

It was first known as the S. P. S. Electrical Club, but in 1909 the name was changed to The University of Toronto Electrical Club. Regular meetings are held every two weeks, at which technical papers are read and discussed. It was thought when the club was formed that the members would enter the discussions more freely in a small meeting than in a large one. This has proved to be the case, and to this fact is due in a great measure the success of the meetings.

Among the subjects discussed during the present term were Wireless Telegraphy, Siemen Bros.' Electric Railway Equipment, Automobile Motors, Commercial Testing of Transformers, Electrolytic Electrifiers, The Oscillograph, Multiple Unit Control, Pennsylvania Electrification, Gas Engines.

An important feature of the work of the Club is the collection of the publications of the leading maunfacturing companies. These are placed on file, and form an increasingly valuable source of information to the members.

The idea of holding excursions to points of engineering in the city originated with the Club. These have always been well attended and have served the useful purpose of giving the students an insight into the practical side of engineering.

The executive for the session 1911-12 is as follows: President, C. De Guerre; Secretary-Treasurer, R. Taylor; 4th Year Councillor, R. A, Storey. The Vice-President and 3rd Year Councillor will be elected next Fall by the 3rd Year.

Under these able officials we bespeak for the Club a prosperous year and a continuance of its prestige among the students.

IMPORTANT MEETING.

The 260th meeting of the American Institute of Electrical Engineers will be held in Toronto on April 7th in the Chemistry and Mining Building of the University of Toronto. The speak-

er will be Mr. W. S. Murray, electrical engineer, of the New York, New Haven and Hartford Railway, who will present a paper entitled "Analysis of Electrification, and Its Practical Application to Trunk Lines for Freight and Passenger Operation." As Mr. Murray is an authority on this subject, the meeting will be one of greatest interest to men in this branch of the profession. The meeting is open to all who may be interested.

THE ENGINEERING SOCIETY ELECTIONS.

P. G. CHERRY, '11

Nominations for office on the executive of the Engineering Society were held on Wednesday afternoon, March 8th, at 3.30 o'clock, in the second year drafting room at the rear of Convocation Hall. It is to be regretted that Convocation Hall was not available for such an important assembly. The Society executive were at a disadvantage by not being advised of the change until almost the last moment, and it can be assured that next year will witness better accommodation for the annual meeting.

Many of the same old "gags" to pull the freshmen votes were sprung as "planks" in the "platforms." But this year has created a precedent in that the President-elect pronounced against the production of problems which had been dealt with, and would be dealt with, merely for the sake of having a platform, for he was elected practically on a non-platform ticket, believing, as he stated, that there would be enough for the next year's executors to handle with the present questions in hand and those which are bound to come up next year, and which cannot be predicted at present.

The two days following the nominations were devoted by the candidates and their supporters to canvassing, and justice was done to the time-honored customs, the presidential candidates, of whom there were no less than four, being exempt from the customs, by unwritten law. Perhaps the posters this year exceeded any hitherto attempted. There were signs of all designs and sizes, some reaching half way across a room, and others draping from floor to ceiling. One candidate enlarged his photo, and used the copies in the various rooms. The introduction of "The Toike Oike," the campaign paper containing principally the advertisements of the candidates and their platforms, etc., was an important feature, being published for three successive days, giving the photos of the presidential candidates in the issue of election day. The idea, we believe, emanated from Mr. J. A. Stiles ('07), B.A.Sc. Mr. R. W. Moffatt ('05), B.A.Sc., was the editor-in-chief, and Messrs. L. S. O'Dell ('07), B.A.Sc., and L. T. Rutledge ('09), B.A.Sc., were the associate editors.

As in previous years, the candidates were given the oppor-

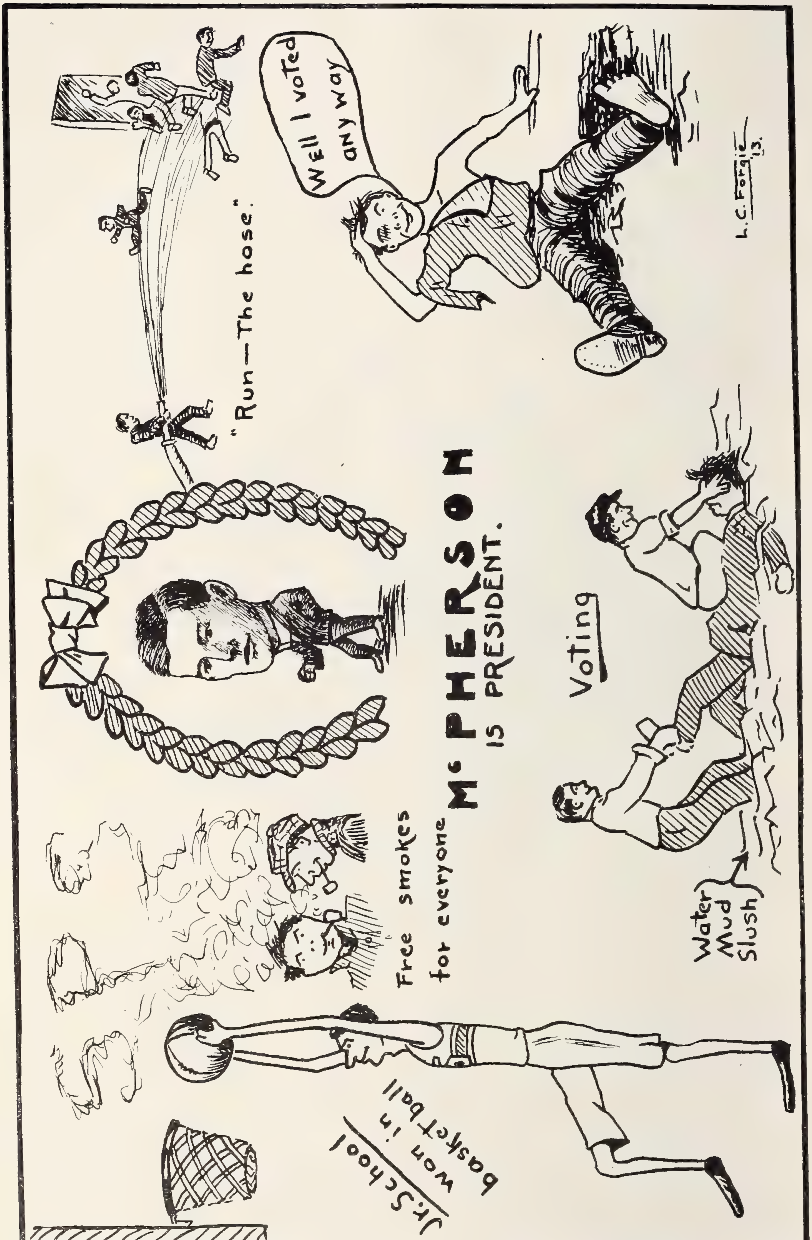
tunity to speak on the day of elections in drafting room "A," the freshmen quarters. The elections took place on Friday, March 10th, the polling being held for one hour in the afternoon at the Engineering Building, proceeding in the evening at the gymnasium from seven to eleven o'clock.

That Friday evening at the gym. typified the school spirit beyond peradventure. It can no doubt be said that the enormity of the occasion has increased in proportion to the increase in the undergraduate body at the school, until the efficiency of the function approaches very nearly 100 per cent. A graduate of many years, who has not looked in for some time, cannot realize the development.

A mud bath was one of the most prominent features. With

W. B. McPHERSON

a full force of "water-boys" operating between the gym. and the heating excavations near by, it took fully three hours to satiate the appetite for mud and water. And such a mob the men did compose, many being saturated with the gluey liquid from top to toe! And how proud they all were of their appearance, just as Diogenes was, before them! Voting has always been a privilege, but never was the opportunity to vote at such a premium. The writer had occasion to relate in "The Varsity" of one rising young engineer of an investigative temperament, who discovered a water tank under the roof. Desiring to demonstrate first-hand


"Run—The hose."
Well I voted any way
L. C. Forgie 13.
McPHERSON IS PRESIDENT.
Voting
Free smokes for everyone
Water Mud Slush
Jr. School won in basket-ball

some of those peculiar and mysterious laws of gravity elaborated in the classroom, a pail of water was suddenly and with a high initial velocity thrust from a cavity in the ceiling and, while only one man received the pail, several welcomed a temporary relief of mud such as was afforded. This slight detail was closely allied to the action of some man who missed his calling, who so neatly and properly cut the beautiful and mud-colored hair of a dignified and lofty freshman. During the tonsorial treatment a refreshing massage of "eau de la muque" was applied to the back, and a few other cursory operations were performed.

One or two of the daily papers were represented at the elections and courteously devoted a few lines to the method of toughness and graft which pervaded. These mild, youthful representatives of the press would have had more to say had they gone "through the mill." The brave men who ventured "through" to vote were rewarded in the usual manner with a corn-cob pipe, a large (!) red package of dangerous-looking straight-cut, and oranges and apples.

Printed programmes of the evening's sport were circulated. The regular contests ran as follows: The fourth year defeated the third year in the tug-of-war, but was finally overcome by the first year, who hopelessly pulled them "all over the lot." The boxing and wrestling and the paper fight all supplied great amusement. In basketball the Juniors defeated the Seniors, but in broomball the Seniors were the victor over the Juniors. However, there were some sensational events not listed. Not the least of these was a real live, energetic, good-natured scrap lasting for a long period. Two of the three men involved were obliged to borrow outfits of overalls, etc., in order to be legitimately clothed to proceed homeward.

This one night, the roughest of the year, at which each man endeavors to look and be his toughest, is, undoubtedly, a fine institution in the faculty. The health and vigor of youth and manhood here show themselves, always rough, never irresponsible, in one great final fling before settling down to the grind.

The executive chosen for the next year indicates strength, and, by what the individual officers-elect promised as candidates, is to be the finest ever. The executive was elected as follows:

President—W. B. McPherson.

1st Vice-President—B. Watts.

2nd Vice-Presidents—Civils and Architects, J. E. Ritchie; Chemists and Miners, K. MacLachlan; Electricals and Mechanicals—G. J. Mickler.

Treasurer—F. Elliott.

Corresponding Secretary—A. McQueen.

4th Year Rep.—W. J. T. Wright (acc.)

3rd Year Rep.—R. F. B. Wood.

2nd Year Rep.—F. C. Mechin.

Recording Secretary—H. A. Heaton.

Curator—R. G. Matthews.

PRESENTATION TO MR. W. J. SMITHER, '04.

A pleasing sequel to the recent Re-Union Dinner of the Graduating Class of 1904, and the Post-Graduate Class of 1905 of the Faculty of Applied Science, was the presentation by his classmates of a gold watch to Mr. W. J. Smither, '04, who for four years has been seriously ill and during the greater part of that time unable to leave his bed. At present Mr. Smither is in the Orthopedic Hospital, 100 Bloor St. west, Toronto, from which he writes the following letter of thanks to those who were concerned in the gift:

Orthopedic Hospital,
Toronto, Feb. 15, 1911.

The Graduates of '04 and Post Graduates of '05.

Dear Classmates,—I take this means of conveying in part my gratitude for the kind and sympathetic manner in which you remembered me at the Re-Union Dinner, and for the beautiful token of our comradeship of student days, which, I know, is but an evidence of your good wishes for my speedy and complete recovery.

Words are inadequate to express my appreciation of your thoughtfulness, but if your pleasure in giving me this beautiful watch be one-half as great as mine in receiving it, you will all know how I feel when I tender you my heartfelt thanks. It will always be a lasting remembrance of the true friendship and sympathy of my old classmates for me in this long illness.

With sincere wishes for your individual success, I am, most sincerely, yours,

W. J. SMITHER, '04.

"Applied Science" extends its sympathy to Mr. W. J. Graham in his bereavement. Mrs. Graham died on Tuesday morning, March 21st, after a lingering illness. Our regrets are on behalf of every graduate and undergraduate of the "School."

DEATH OF M. T. CULBERT, '02.

On Tuesday, March 14th, Mr. M. T. Culbert, B.A.Sc., succumbed to appendicitis in St. Michael's Hospital, Toronto. Mr. Culbert, as manager of the O'Brien Mining Company, Cobalt, was one of the most prominent among mining men, and will be sadly missed by his associates in Northern Ontario, and by all who knew him, professionally or as a classmate.

G. B. ARMSTRONG, '14.

The death was announced of Mr. G. B. Armstrong, a member of the Class '14, who died at his home in Owen Sound a short time ago.

THE CANADIAN CEMENT AND CONCRETE ASSOCIATION.

Regarding the exhibition of the Canadian Cement and Concrete Association, held recently in Toronto, The Toronto Daily Globe, editorially, has this to say:

"The Cement Show, which has been open for several days, is one of the most attractive industrial exhibitions Toronto has ever had. Its drawing power is due not so much to its appeal to the sense of the beautiful as to the growing importance of cement for a great variety of industrial purposes. These have multiplied in number so rapidly in recent years as to be positively bewildering to all but the experts, and even they find it difficult to keep up with the procession."

The Canadian Cement and Concrete Association organized in Toronto in April, 1908, has been patterned after the Concrete Institute of Great Britain, and the National Association of Cement Users of the United States, each of which has established itself in its own country as an authoritative educational body on matters relating to the uses of cement and concrete. Similarly the Canadian Association aims at advancing the knowledge of concrete and reinforced concrete, and directing attention to the uses to which these materials can be best applied. It will shortly issue a volume of proceedings for the year, a feature of which will be its standard specifications. That the Association is not a money-making organization is evidenced by the fact that it costs practically twice as much to conduct the annual exhibition and convention as is received from the price of admission, and the sale of space.

The papers read at the convention were, for the most part, of a superior kind, and the discussions following them were instructive. Mr. Richard L. Humphrey, director of the Federal Testing Laboratories of the United States, contributed two papers, both of which were listened to with much interest. It is probable that the next meeting will be held in Montreal.

THE U. OF T. CLUB IN PITTSBURG.

The University of Toronto Club of Pittsburg has a large membership that is constantly growing. The Club, primarily composed of graduates from the Faculty of Applied Science, includes all other faculties of the University that may be represented in Pittsburg or vicinity. At the annual meeting for the election of officers, at the Hotel Henry, a short time ago, the following officers were elected for the ensuing year:

President—H. M. Scheibe.

Vice-President—D. W. Marrs.

Secretary-Treasurer—J. G. R. Alison, 55 Water street, Pittsburg.

THE D. L. S. AND O. L. S. EXAMS.

The following are the names of the men who were successful at the recent Dominion Land Surveyors' examinations: C. E. Bush, '07; G. C. Cowper, '07; F. M. Eagleson, '08; A. E. Glover, '09; J. E. Gray, '09; W. J Johnston, '09; R M. Lee; E. S. Martindale, '09; O. W. Martyn, '09; F. V. Seibert, '09; C. M. Walker, '09.

Those successful in the Ontario Land Surveyors' examinations are as follows: R. M. Anderson, '08; H. W. Tate, '09; J. T. Ransom, '08; C. B. Allison, '08; W. E. Taylor, '09; W. G. McGeorge, '08; J. E. Jackson, '09; J. A. Brown, '07; A. E. Jupp, '06; R. Grant, '09; graduates of the Faculty of Applied Science, and N. J. Slater, A. McMeekin, A. Roger, and C. H. Attwood, of other universities.

ERRATA.

In the article entitled, "Incandescent Lamps," by M. B. Hastings, in February issue (Vol. IV., No. 4) the last lines of page 128 should read, "At the present time the 'Mazda' lamp is composed of tungsten filaments, but if carbon or some at present unknown filament be found which would result in a lamp of higher efficiency than the present tungsten filament lamp, it would be the 'Mazda.'"

Again, on page 130, the percentages in the first line should read 0.45 and 0.18 respectively, and the fifth, 35 per cent. instead of 3 per cent.

(Mr. Hastings' paper is a valuable one, and we regret the overlooking of this, at the proper time. Readers will confer a favor by pencilling the necessary change.)

WHAT THE GRADUATES ARE DOING.

J. T. Johnston, '08, is assistant engineer, section five, Trent Valley Canal.

T. H. Alison, '92 is Secretary and Chief Engineer of the Bergen Point Iron Works, Bayonne, N. J.

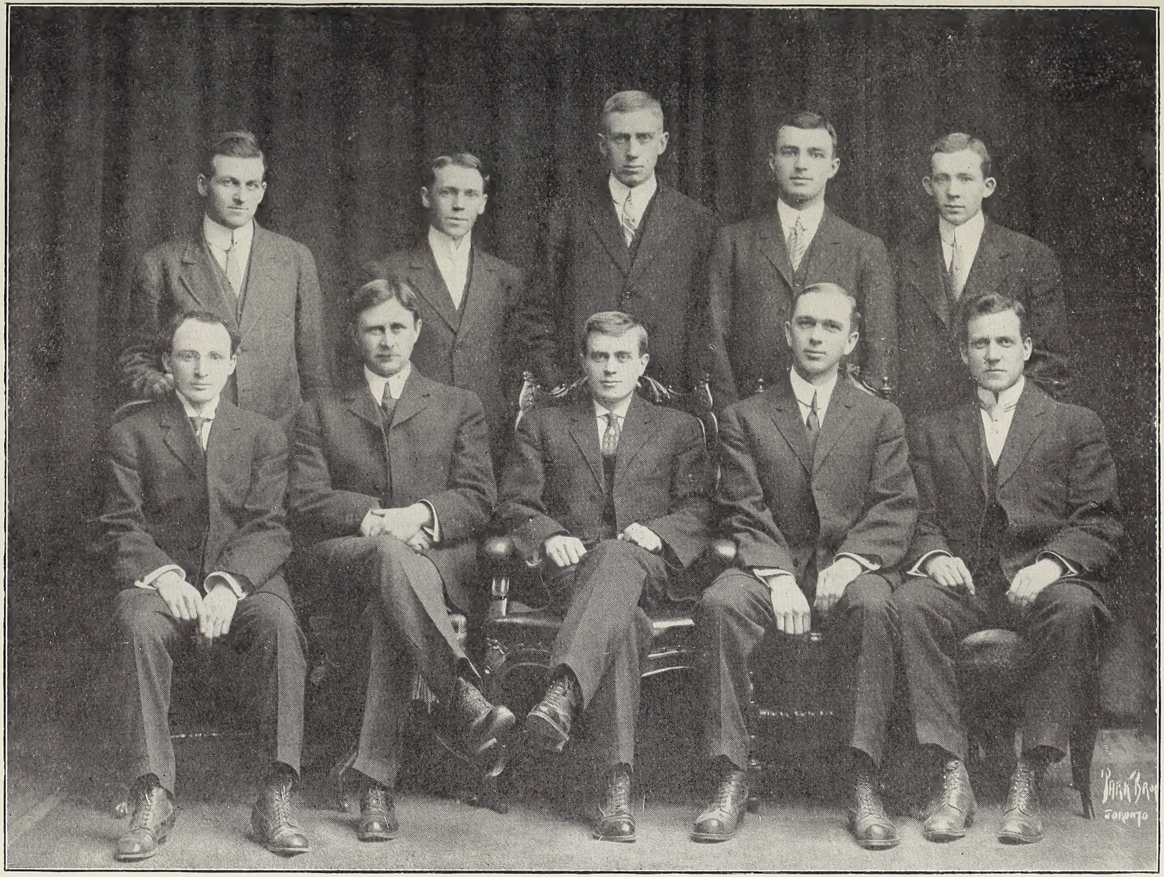
James A. Beatty, '03, is in business in Peterboro' with Morrow and Beatty, general contractors.

E. R. Birchard, '09, is in charge of the drafting and designing for the Canada Producer and Gas Engine Co., Barrie, Ont.

J. H. Kennedy, '88, is chief engineer for the Great Northern Railway, Vancouver, B. C.

H. E. Brandon, '06, is chief engineer for the Vulcan Iron Works, Winnipeg.

H. S. Carpenter, '97, is Superintendent of Highways, Dep't of Public Works, Regina.



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